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School Plant for Power, Heating and Ventilation

COMBINATION HEATING SYSTEM; OVERHEAD COILS IN GYMNASIUM AND NATATORIUM; AIR PRESSURE WATER SUPPLY

TO REDUCE MATERIALLY the operating expenses of the Cicero and Stickney High School at Cicero, Ill., which is one of the most modern and attractive institutions of its kind in the Middle West, it was decided to replace the low-pressure steam plant with a high-pressure installation, discontinuing the purchase of power from a public service company, and a large addition to the building was recently completed in which generating apparatus rated at 150 kw. was installed.

Briefly considered, the requirements are these: Power is needed for driving the ventilating fan and pumps, for lighting, and for operating the machinery in the manual training department. Direct heating is required for 50 class rooms, an auditorium, gymnasium, and natatorium, and hot water for the natatorium, shower baths and kitchens. In addition to the usual day sessions, 2½-hr. night classes meet 3 times a week.

SCOTCH MARINE BOILERS

FOR THE GENERATION of steam, 2 Freeman internally fired boilers were installed, each rated at 300 hp. and having a diameter of 11 ft. 6 in. Figure 3 shows one of the boilers being drawn into the building by the aid of cables.

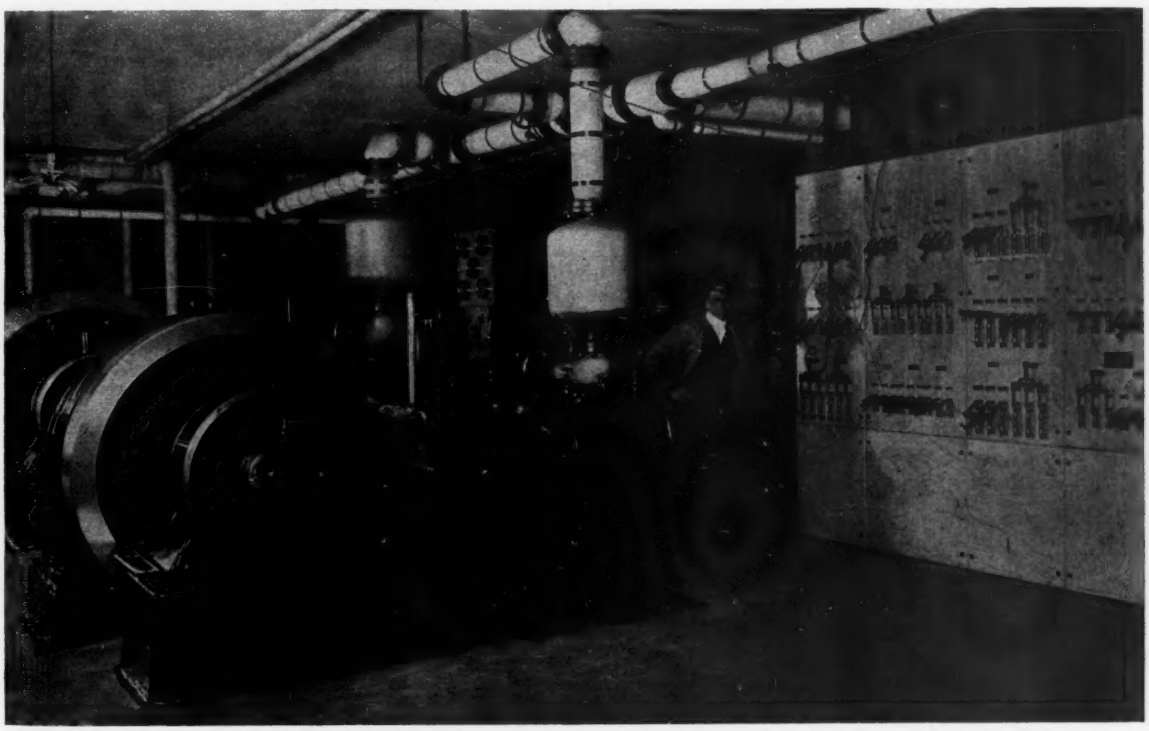


FIG. 1. ENGINE ROOM OF CICERO AND STICKNEY HIGH SCHOOL

Although the operating pressure used is 100 lb., the boilers were designed for a pressure of 160 lb. and the shells are 1 1/16 in. thick. Longitudinal seams on the cover plates are triple-riveted, the girth seams being double riveted. Each boiler contains 2157 sq. ft. of heating surface and is equipped with 2 Morrison corrugated furnaces of 9/16-in. steel, with an internal diameter of 50 in. The ratio of grate to heating surface is 1 to 40.

Each boiler is provided with 3 10½ by 16-in. manholes, one in the top of the shell and one at each side, and 2 4 by 6-in. handholes which are placed in the front

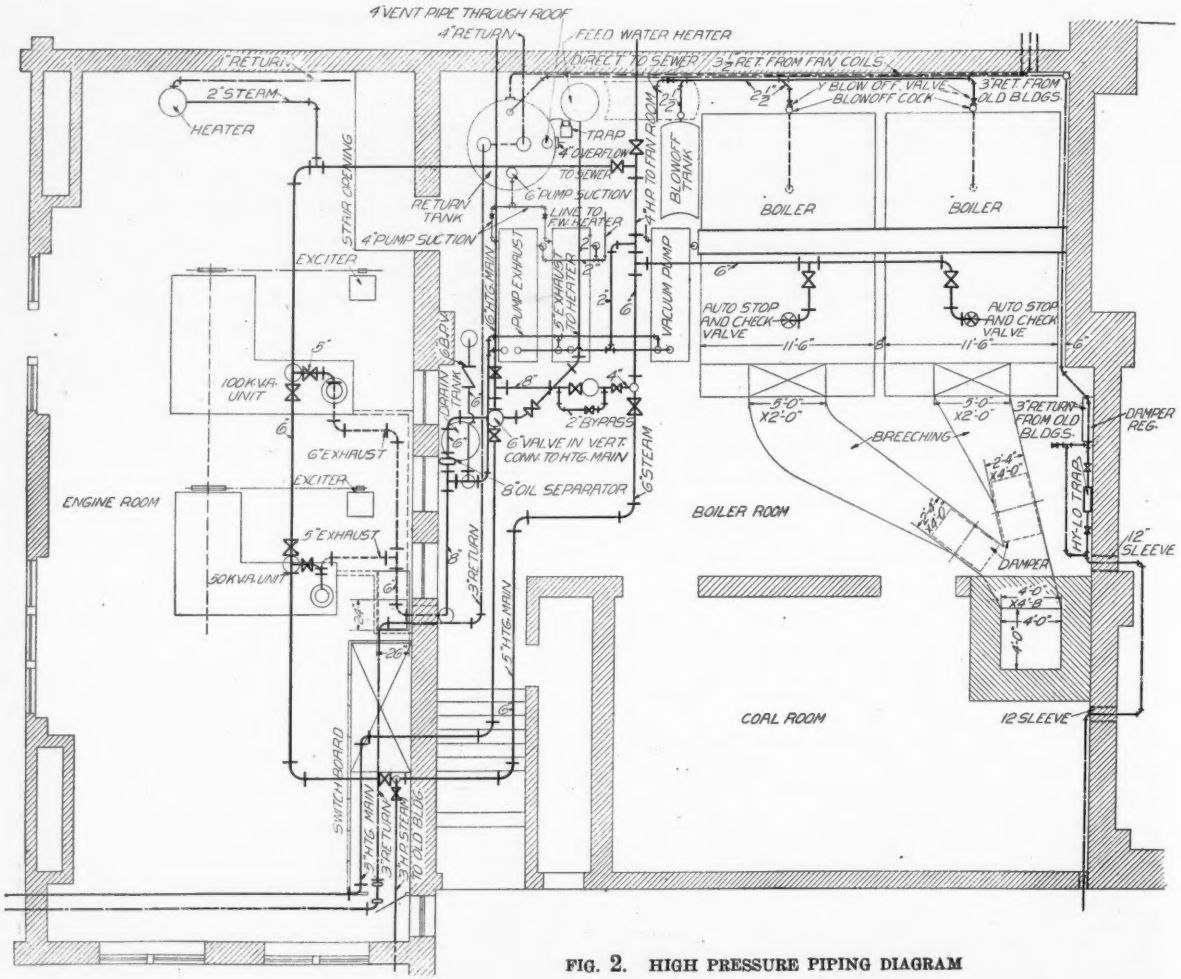


FIG. 2. HIGH PRESSURE PIPING DIAGRAM

sheet below the tubes. The boilers are set in cast-iron cradles which rest upon a concrete foundation 2 ft. thick.

Draft is supplied by a brick stack 4 ft. square,

High Pressure Piping

Live steam is supplied direct to the 2 main engines and a fan engine, and through pressure reducing valves to the gravity heating system of the old building and the hot water heaters for the swimming pool and shower baths.

Beginning at the boilers, 5-in. branches are connected to a 6-in. header, at one end of which a 6-in. loop is carried around the engine room and back into the boiler room, as shown in Fig. 2. The 2 main engines are supplied by 4 and 5-in. branches, respectively. Running through the natatorium to the fan room is a 4-in. high-pressure line which is connected to the fan engine through a 2½-in. branch and through reducing valves to the air heating coils and swimming pool heater by 3-in. and 2-in. branches, respectively.

From the loop in the engine room a 3-in. line is carried to the reducing valve in the old building and a 2-in. line is connected through a reducing valve to the shower bath heater.

Two high-pressure drains are provided, a 1-in. drain being taken from the bottom of the tee, where the connection is made between the boilers and the loop, and a 1-in. drain taken from each of the separators in the branches to the engines. Each of these drains is brought to an extra heavy receiver, about 30 in. in diameter located at the wall of the boiler room, and has immediately adjacent to the point of drainage an angle or gate valve.

Electric Generators

Alternating current, at 220 volts and 60 cycles, is generated by a 100-kw. Western Electric machine, driven at 257 r.p.m. by a 16 by 16-in. single valve Ball engine, and a 50-kw. Western Electric machine which is operated at 300 r.p.m. by a 12 by 12-in. Ball engine

of similar design. Exciting current is obtained from 2 Western Electric 8-kw. exciters which are belt connected to the main generators.

Current is regulated, recorded and distributed by means of a 7-panel white marble switchboard equipped with Westinghouse meters. For lighting, current is reduced to 220 to 110 volts through balance coils. Four 100-watt lamps is the standard installation in the classrooms.

Forming the power load of the manual training room are 15 ½-hp. induction motors operating the woodworking lathes and 4 motors with a total of 14 hp. which drive the saws and planers. Driving pumps in the basement are 5 induction motors ranging from 1 to 10 hp.

Pumps and Heaters

Feed water is supplied by 2 Worthington duplex pumps, each 7½ by 4½ by 10 in. which discharge to the boiler through a Kelley closed heater, each 2-in. branch to the boiler containing a gate valve, check valve and angle valve. Vacuum for the heating system is provided by an 8 by 12 by 12-in. Marsh pump which is placed adjacent to the feed pumps as shown in Fig. 6.

Service water for the basement and first floor is taken direct from the city main having a pressure of 15 lb. and an air pressure system is employed to force the water to the 2nd, 3rd and 4th floors. Placed underground is a horizontal supply tank 5 ft. in diameter and 30 ft. long which ordinarily contains 2/3 water and 1/3 air having a pressure between 30 and 55 lb. As water is drawn from the tank, the pressure decreases and when the minimum of 30 lb. is reached, a motor-driven centrifugal pump is thrown in action by means of a Cutler-Hammer automatic pressure regulator which cuts off the pump when sufficient water has been forced into the tank to produce the 55-lb. pressure. To maintain standard conditions it is occasionally necessary to replace such air as has escaped with the water by operating a small motor-driven air pump. The centrifugal pump which supplies the tank has a 3-in. suction and 2½-in. discharge and is driven at 1800 r.p.m. by a 10-hp. induction motor.

FIG. 3. MOVING BOILER INTO BUILDING BY AID OF CABLES

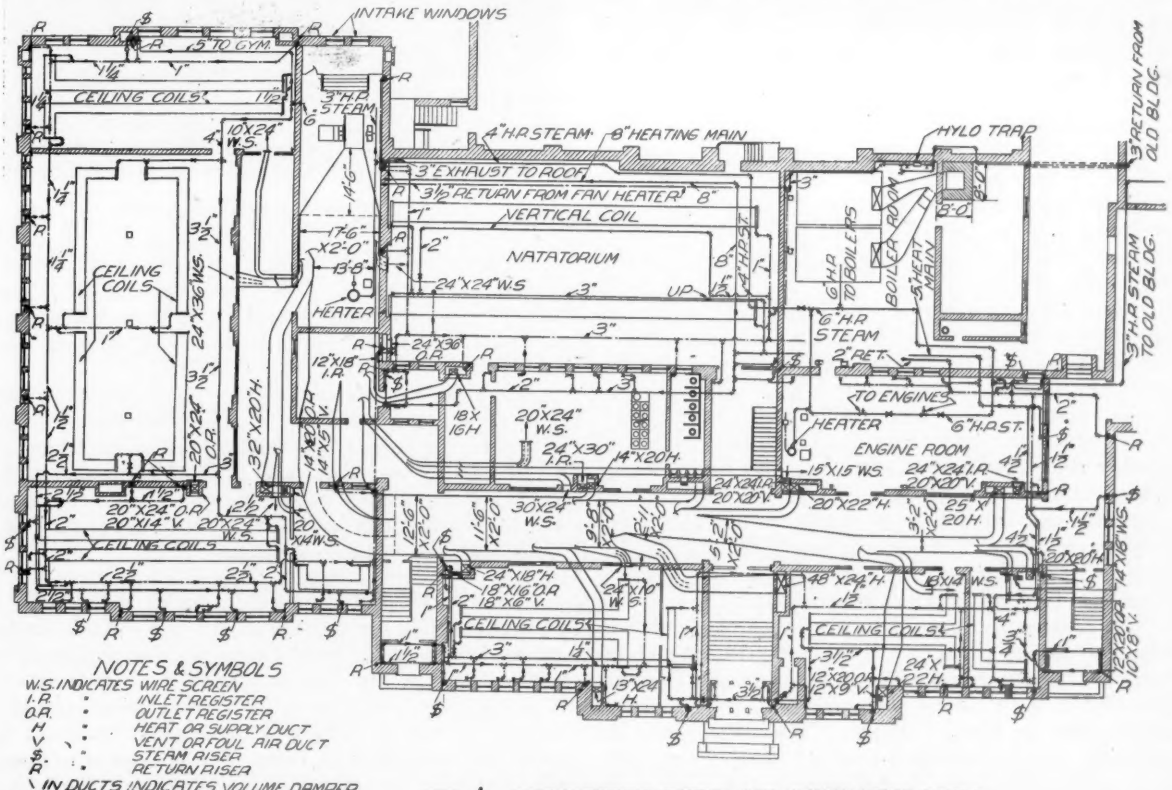


FIG. 4. LOW-PRESSURE PIPING AND VENTILATING DUCTS

Water for the 20 by 60 ft. swimming pool may pass directly into the pool through a 3-in. line or may be circulated through a Clow heater containing 119 sq. ft. of 2-in. coil and enter the pool through two 2-in. lines. Connected at the opposite end of the pool are two 2-in. lines which return the water to the heater from which it passes to a filter tank, where filtration at the rate of 48 gal. per minute is downward through a bed of graded sand superimposed upon layers of graded quartz. From the filter the water again passes into the pool, circulation being maintained by a 2-in. centrifugal pump operated at 900 r.p.m. by a 2-hp. induction motor. A similar pump is employed to drain the pool in cleaning, the bottom outlet being 1-ft. below the level of the sewer.

Situated in a corner of the engine room is a heater which warms the shower bath water and is similar in size to the swimming pool heater. Each heater receives

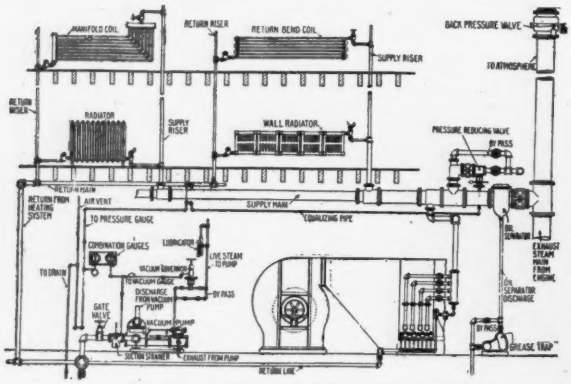


FIG. 5. VACUUM RETURN HEATING SYSTEM

steam at 25 lb. pressure through a reducing valve and is equipped with a Powers regulator to maintain the desired temperature.

Exhaust and Low-Pressure Piping

Exhaust outlets from the 2 main engines connect to a 6-in. exhaust line carried in a trench which rises in the boiler room and connects to an 8-in. exhaust header equipped with an oil separator. This separator is drained through a 1-in. balanced trap discharging to the drain tank.

From the fan engine a 4-in. exhaust having an oil separator is connected to low-pressure heating main in the fan room and also through a horizontal back pressure valve to a 3-in. exhaust line which rises to the roof of the natatorium.

Heating steam is distributed by 2 mains, a 5-in. line passing through one end of the engine room and then around the west wall of the building, while an 8-in. line passes through the natatorium as shown in Fig. 4. The smaller main supplies 9 risers varying from ¾ to 2½ in., and the large main serves 11 risers from 1 to 5 in., the 5-in. riser feeding the gymnasium coils.

All risers which have radiators connected having no separate return are provided with a drip pipe at the bottom of the riser. Drains into the return lines are provided at the ends and at any pockets of all the steam supply lines to direct radiation. The return from the warming coils in the fan chamber is carried under the floor of the natatorium in a 6-in. split tile.

All radiators, either of the regular design or wall type, are supported on the wall by 2 concealed brackets at the top and 2 at the bottom, the brackets being made of ⅛-in. steel and secured to the wall by ⅝-in. expansion bolts.

Vacuum Return Heating System

Operating ordinarily with 1 in. pressure and 11 in. vacuum, a Warren Webster vacuum system serves the 9000 sq. ft. of radiation of the new building while the old building having approximately 2000 sq. ft. of radiation is still heated with a gravity return system which receives its steam through a 3 by 6-in. reducing valve. Connections for a typical Webster vacuum return system are shown in Fig. 5.

In a building of this character, heating of the room containing the swimming pool probably demands the most careful consideration and in this instance, heat for the natatorium is supplied by 3 overhead coils. Immediately below the roof trusses are 2 horizontal coils,

FIG. 6. FEED AND VACUUM PUMPS

each consisting of 16 1¼-in. pipes, 85 ft. in length, and containing 570 sq. ft. of radiating surface. Supported by the vertical members of the trusses is a vertical coil consisting of 8 1¼-in. pipes, 77 ft. long, and having 268 sq. ft. of radiation.

Overhead coils having 944 sq. ft. of radiation, and similarly supported in the roof trusses, are supplemented by 15 wall radiators with 2690 sq. ft. of radiation in heating the gymnasium, which is 100 ft. long and 76 ft. wide. Steam supply pipes for these wall radiators, which are hung with their bottoms 8 ft. above the floor, are also carried in the roof trusses.

Automatic Control of Heating and Ventilation

Connections for thermostatic control for this combination direct heating system with positive ventilation is shown in Fig. 8. In this installation the Powers system of regulation is employed, each room being provided with a thermostat which automatically controls, by means of the diaphragm valves, G, the amount of steam admitted to each radiator.

Located in the discharge duct from the fan is another thermostat, E, which, through the relay valves, D, operates the 3-in. diaphragm valves, C, controlling the amount of steam supplied to the warming coils, A. Applied to coil control as shown, the relay valves enable the thermostat to handle the diaphragm valves easily, and can be so adjusted as to operate the diaphragm valves successively, one following the other as the temperature varies. In order that a proper amount of unheated air may be mixed with that which passes through the warming coils, a bypass damper, L, is provided which is also under the control of the thermostat, E, and operated by the diaphragm motor, M.

Compressed air is used for control of the diaphragm valves and ventilating dampers and is furnished by a motor-driven compressor, H, located in the engine room, and equipped with an automatic governing device to maintain a pressure of 15 lb. in the air tank, I, which is placed on the wall of the boiler room.

Driven at 156 r.p.m. by a 10-hp. engine is a Sturtevant multivane fan which draws 39,000 cu. ft. of air per minute through the warming coils and into the main air duct which is placed in the basement ceiling and follows the line of the corridor as shown in Fig. 4. Adjustable deflector dampers at the junction of the branches with the main duct and supplementary volume dampers are provided to secure an even distribution to the different rooms.

Moisture is introduced into the air by a steam jet humidifier discharging live steam through an arrangement of perforated pipes situated at the rear of the heating coils. The supply of steam to the humidifier is regulated by a 1¼-in. diaphragm valve which is automatically controlled by a Powers hygrostat located centrally in the building, compressed air serving as the operating medium between them.

Inlet registers with louvres are located 8 ft. above the floor; outlets with no louvres are as near the floor as possible. The size and location of the distributing ducts and basement registers are shown in the plan view, Fig. 4. Air for the gymnasium is taken from a 32 by 20-in. vertical supply duct through a 24 by 36-in. register, which is provided with a 21 by 13-in. deflector elbow extending down into the duct.

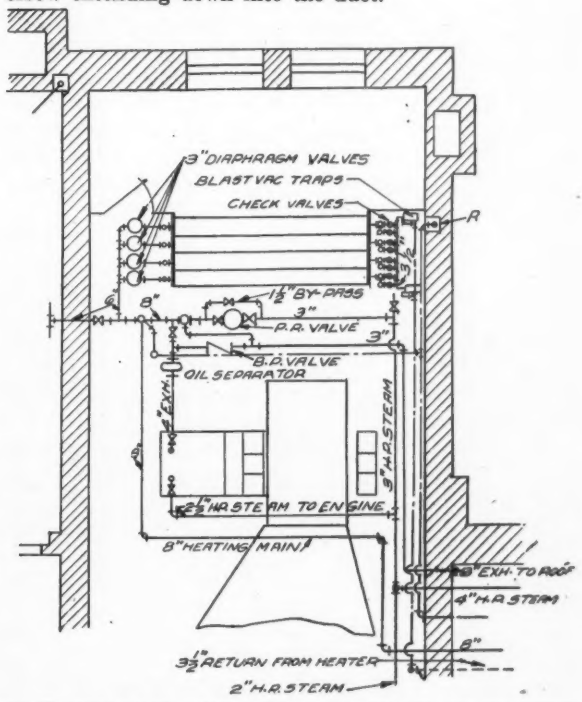


FIG. 7. DETAILS OF CONNECTIONS TO FAN AND AIR WARMING COILS

For discharge ventilation the slight pressure within the rooms by the action of the fan is sufficient, and no exhaust fan is employed. Vent flues are carried up separately to the attic when they are connected to a central shaft extending through the roof.

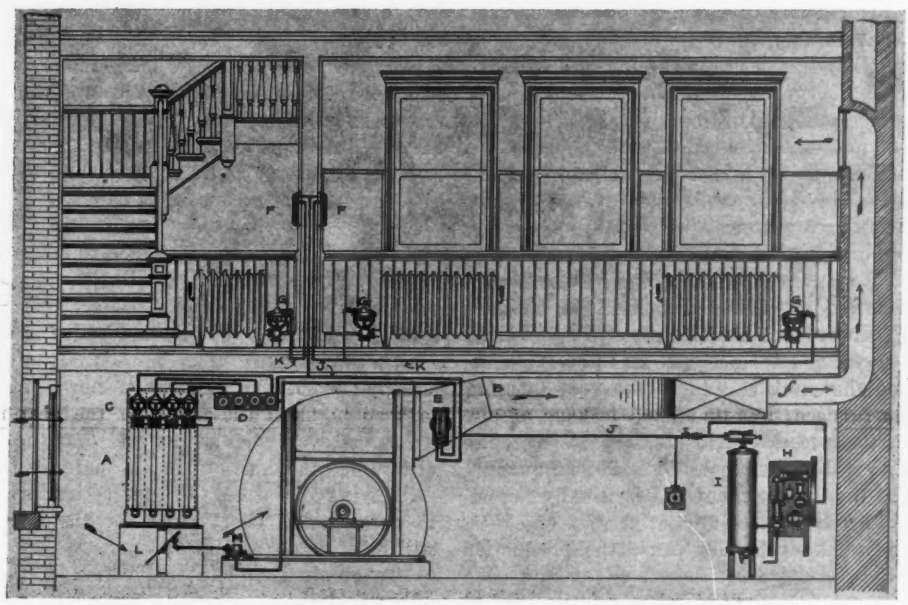


FIG. 8. SYSTEM OF THERMOSTATIC REGULATION

Economy in the Use of Coal—III

PRACTICAL SUGGESTIONS ON HANDLING FIRES WHEN CO_2 RECORD IS KEPT. BY A. BEMENT

THE cause of incomplete combustion is popularly ascribed to a deficiency in air supply, and while this view prevails as it does at present, only confusion will result in an effort to produce economical combustion. The belief that deficient air is the cause, is practically true to only a slight extent. Cases have occurred where the maximum efficiency obtainable under a prevailing faulty condition, was as low as 7 per cent, and any attempt to obtain higher by limiting air supply while the condition prevailed was accompanied by a decline in efficiency, notwithstanding that air was at least 250 per cent greater than the chemical requirements. The cause of this state was not a deficiency of air in the furnace, but failure of it to come in contact with the combustible matter while at a sufficiently high temperature for combination to occur.

In explanation it should be said that this was the case of a water-tube boiler, with its exposed tubes set close to the fire. Firing was by hand and it was very unskillfully performed, large masses of coal being piled in the furnace at irregular intervals. The result was that the volatile combustible of the fuel was distilled in great mass, to the interior of which the air had no access. The result was that the combustible gas was quickly cooled by the tubes of the boiler, and by the time that the air did get mixed with it, temperature was too low for combustion.

Experience with such condition as illustrated by this example has caused some to believe that an amount of CO_2 much less than the maximum was the most economical to maintain, and that the CO_2 should be kept down as well as up, or in other words, that a middle course should be adopted. This would be true if it were impossible to correct such a condition; but, as it is always possible to do so, it is an error to assume that any except the highest CO_2 is preferable, and the remedy is not to keep down the CO_2 but to correct the incomplete combustion.

DEFICIENT AIR SUPPLY

THE PRINCIPAL cause of incomplete combustion of carbon to carbon monoxide, is deficient air supply; this does not, however, apply to the whole furnace, as the deficiency is what may be termed local. For example, an accumulation of ash or clinker on the grate obstructs the supply of air to the coal above. The result is that there is a formation of carbon monoxide, which does not get a chance to burn because it escapes in a mass to which the air does not have access. At the same time, the presence of the clinker reduces the coal burning capacity of the furnace; but that fixed leakage of air, always present to some extent in all furnaces, becomes proportionately greater, due to the reduced coal burning capacity. Thus the formation of CO is usually accompained by an increase in excess air. Excessive thickness in fuel bed, or weak draft also cause the production of CO.

Incomplete combustion of escaping volatile matter, is caused by the formation of masses of gas that escape without burning. In detail the performance is as follows. Large masses of coal or pieces of coal of very large size, when put on the fire have the volatile matter roasted from them in a large mass, to the outside of which air has access, causing combustion on the outside. These masses of gas are generally called flames. Fresh coal placed on the fire above an accumulation of clinker, causes the production of a large gas mass or in other words a large flame. Such flames are so large and massive that the air does not get mixed with them until too late.

This is a characteristic performance of a hand fire, and with it the loss is more severe if the boiler is one of the type in which the gases pass immediately among the tubes. With stoker conditions where the feed of coal is uniform, the flames conform in size, and as small uniform sized coal is used comparatively small flames result, and these flames will burn away if they do not come immediately in contact with tubes of the boiler so that combustion is interrupted.

HEAT AND FLAMES

IT IS quite generally thought that long flames which reach out and extend over the boiler surface, are desirable, and that such flames have an important heating effect. This is not true, however, as the following will show. Carbon burned to CO_2, which is a colorless gas, is accompanied by full heat development, therefore there can be no luminous flame accompanying such combination. But flames are an accompaniment of all fire, and it is necessary to have a clear understanding of their nature.

When a piece of coal enters the fire, the first thing that occurs, before any combustion begins, is a distillation of the volatile matter. This volatile matter emerges as a mass of hydrocarbon gas, which is immediately acted upon by the heat of the furnace, with the result that the combination is broken up, the carbon going free as a solid particle. This solid particle necessarily becomes luminous by being heated from the fire, and it is these carbon partieles in their luminous state which give the appearance known as flame.

Immediately, however, upon oxygen coming in contact with these particles, union takes place and combustion is accompanied by the disappearance of the luminosity of that particle. Thus flame is not a condition of combustion, but a state which is endeavoring to attain combustion. The best fire is always one with least flame. In this connection, however, it is necessary to keep in mind the fact that the heat is transmitted by the gases of combustion, and that the invisible gases of complete combustion are adequate for the purpose.

Having discussed the combustion process somewhat in detail, some short rules for the operation of fires will be of value, as follows:

To obtain complete combustion of the solid carbon of the fuel:

1. Maintain a clean fire.

2. Do not get the fire too thick.
3. Provide sufficient strength of draft.

To prevent the escape of volatile combustible matter:

1. Maintain a clean fire.
2. Secure uniformity in the supply of coal to the fire, both in rate and distribution.
3. Supply the coal in reasonably small pieces.
4. If the flames come in contact with the boiler before they are burned out, increase the distance between the fire and the boiler, or protect the burning flames by an arch over the fire, or its equivalent.

Consideration of the prevailing CO_2 in connection with the foregoing 7 conditions, as illustrated by Fig. 10, page 153, Feb. 1 issue, will give most definite and convenient information.

In the regulation of the air supply, if found in excess the disposition is often to reduce the draft by partly closing the damper. This is frequently followed by failure to secure improvement, the reason being that the regulation of the air supply is the last thing that should have attention, because other things should be corrected before it can be attempted. For example, if at one time there be a very large quantity of fuel in the fire, it may be impossible to get complete combustion with any amount of air, and if followed by the burning away of the fire to a low state, then air will be greatly in excess.

It therefore follows that a uniform condition of fuel and fire should be first maintained, when this is done, it will be indicated by a uniformity in the CO_2, it may be low but it will be uniform. When this is attained the regulation of the air supply may be accomplished, and this should be done not so much by changing the draft as by the amount of the fuel supply. The full air supply should be utilized before it is changed, or in other words the CO_2 should be brought up before the damper is changed. If the matter is viewed from the standpoint of the air supply, instead of the coal feed, it will be made clearer.

Assuming that the horsepower may be produced by 3.5 lb. of coal, and that 200 cu. ft. of air per pound of coal be the right amount, it follows that 700 cu. ft. of air are required per horsepower, to satisfy, or to saturate, as it may be termed, this quantity of air to the extent of 15 per cent CO_2. The first thing to do, therefore, is to satisfy the air, after which, if too much steam is made, or the work is too much for the fireman or for the furnace, the air supply may be reduced. When this is done, a less quantity of steam will be made. From this explanation, the following general rule may be derived:

To regulate the air supply:

1. Produce and maintain uniformity as to fuel supply, and condition of fuel bed.
2. Note the resulting CO_2, and increase or decrease it, as necessary, by changing the fuel rate.
3. If too much steam is made, reduce the draft but maintain the CO_2, or reduce the number of boilers in use, or the grate surface, depending on conditions.

As a general rule, it is always desirable for furnaces to work at what may be called their natural capacity, which is also their maximum capacity. Thus in large plants it is usually preferable to work boilers at their maximum capacity, banking or shutting down those not required. Recently, however, an attempt has been made on a limited scale, to operate certain furnaces at reduced capacity, but maintaining the CO_2. If this should prove successful, it would be a scheme of merit.

While the foregoing has dealt largely with bituminous coal, it applies to anthracite coal and oil, except that with the former, the feature of the volatile matter is quite unimportant. With oil the matter is quite simple if good furnace construction prevails. Then the control of the air supply, according to CO_2, is very nearly the whole of the problem and as long as there is no smoke made, combustion will be complete.

An attempt has been made in the foregoing to present the combustion process in some detail, and to illustrate its various phases. It is the experience of the writer, based on many year's practice, that for the best results to be had, it is essential that the fireman, the engineer, the manager or proprietor, as the case may be, study the record made by an automatic CO_2 recorder, in connection with the observable phenomenon. In this way may the efficient operation of furnaces be facilitated. It is always desirable for the fireman to attempt an explanation of why the CO_2 is high or low, and for the engineer or manager likewise to seek studiously for the same information, always keeping in mind that if the fire is clean, there will be no incomplete combustion, and if no smoke, that there will be no escaping volatile matter.

JAPAN WILL have the tallest chimney in the world, reaching a height of 567 ft. Under the guidance of American engineers, the great stack is being erected in the town of Saginasaki on the east coast for the Kuhara Mining Co., which is building a new smelter. The foundation is placed on top of a hill which rises 430 ft. above the level of the sea, and from the seaside, counting the altitude of the cliff, there will be an almost straight rise of about 1000 ft. to the chimney top. At present the world's highest chimney is at Great Falls, Mont., with a height of 506 ft.

THE FOLLOWING-NAMED U. S. Civil Service examinations will be held on various dates between March 12 and May 23, 1917: Clerk, Departmental Service; Elevator conductor, Departmental Service (men only); General mechanic, Departmental Service (men only); Stenographer, Departmental Service; Stenographer and typewriter, Departmental Service; Stenographic clerk, Departmental Service; Subclerical (messenger, skilled laborer, and watchman), Departmental Service (men only); Typewriter, Departmental Service.

Application forms and full information may be obtained by addressing the U. S. Civil Service Commission, Washington, D. C.; or the Secretary of the Board of Examiners at the following-named places: Post Office, Boston, Mass.; Philadelphia, Pa.; Atlanta, Ga.; Cincinnati, Ohio; Chicago, Ill.; St. Paul, Minn.; Seattle, Wash.; San Francisco, Cal.; Customhouse, New York, N. Y.; New Orleans, La.; Honolulu, Hawaii; Old Customhouse, St. Louis, Mo.; Administration Building, Balboa Heights, Canal Zone; or the Chairman of the Porto Rican Civil Service Commission, San Juan, Porto Rico.

Coal and Ashes Handling and Storage---I

BIGGER PROFITS AND BETTER BOILER EFFICIENCY BY SAVING THE FIREMAN'S BACK. BY HENRY J. EDSALL

ECONOMICAL HANDLING OF coal and ashes at power plants, including the providing of suitable storage facilities, has progressed to a remarkable degree in the last few years. The results aimed at, as indicated by the title, are the added profits to be obtained by saving expense in the handling and by increasing the efficiency of the boilers, and also by the avoidance of expense and loss of prestige by providing a storage that will insure continuous operation and eliminate actual or threatened interruptions, which run into expense so rapidly. There are, therefore, two quite distinct phases to be considered when designing a coal and ashes handling equipment.

First: The saving in the cost of handling and in the amount of coal consumed, and when these savings are translated into dollars and cents, the total should show a good return on the investment; otherwise, the design or something else is wrong, for it is definite added profits by saving in expense that is aimed at in this phase of the problem.

Second: The providing of proper storage facilities, usually an active storage of moderate size to take care of ordinary conditions at a minimum expense and a reserve storage large enough to eliminate any danger of closing down the plant, or even any likelihood of such a happening which might make additional expense seem advisable in order to avoid it.

RESERVE STORAGE

THE SECOND phase of the problem is not quite so clean cut, since the amount of both active and reserve storage justified is open to argument, as is also the amount of investment justified for equipment to store the reserve coal and to use in transferring it to the active storage. If the regularity of the daily supply can be relied upon with considerable certainty, little, if any, reserve storage or equipment for handling and transferring this reserve coal is justified, as it will probably not be needed. As the likelihood of irregularity of the daily supply increases, the greater will be the amount of reserve storage justified. The handling equipment justified for the reserve storage depends largely on the amount of coal per year likely to be delivered to this storage and transferred to the active storage.

Where the amounts of coal consumed are large, the use of the reserve storage may be quite extensive, and the saving of a few cents per ton will amount to enough in a year to justify quite a large investment. Even in some of the smaller plants where the supply is not very regular, the reserve storage comes into frequent use and the yearly total of coal handled in this way is sufficient to justify considerable investment. In other plants the reserve storage is used only at long intervals, so that the amount of coal handled per year is small, and even though the handling cost per ton may be quite high, the yearly total will not amount to a great deal and little investment, for reducing this cost, is justified. In some cases the facilities for receiving or purchasing coal depend more or less on the season, so that it may be inconvenient to get coal, for instance, in winter, and in such cases storage plants are provided of a capacity large enough to furnish the supply during the time when coal is not coming in. Even though the daily consumption may be comparatively small, it may be better to spend considerable money for a storage and handling equipment rather than to have additional expense for obtaining coal during the off season, or having to pay higher prices or purchase inferior coal at certain times.

From the above it will be easily seen that in designing a comprehensive coal handling system, many factors have to be taken into consideration, and, unless an engineer has had considerable experience in this kind of work, some of these factors are likely to be overlooked or not given proper consideration, so that without an intimate knowledge of all the possible methods of accomplishing the desired results, the most suitable and economical scheme may not be selected. This is true not only of the general arrangement of the equipment, but also of the details, for probably in no class of machinery are the design and construction of the details of more importance than in machinery for handling materials. It is a wear-resisting proposition, so that two equipments which may be similar in general appearance may give very different results, depending on the intelligence and care used in the design and construction and in the selection of materials for the small details. The experience and honesty of the builder of such equipments are the best guarantee of their lasting qualities and economical operation.

Another important point is to make a comprehensive study of the whole problem before deciding on any particular type of building or location of active or reserve storage. Too many engineers are prone to follow some precedent with which they happen to be familiar, instead of submitting the problem to a specialist in this class of work, who could, in all likelihood, suggest a better and more modern method of accomplishing the desired result, and possibly effect a saving in the cost by selecting a less expensive type of building or bin or a better arrangement of the component parts of the equipment.

INCREASED BOILER EFFICIENCY

MENTION has already been made of the possibility of increasing the efficiency of boilers by getting a better combustion in the furnaces. This is a possible saving in a plant equipped with mechanical stokers, of which the importance is not fully appreciated. It is to be obtained by the proper sizing of the coal, so that it will be most suitable for the particular type of stoker which is to be used, and by arranging a proper feed to the stokers so that the operators can give their undivided attention to operating the stokers in the most efficient manner, without having any added burdens of breaking

up lumps of coal or any shoveling of coal or other labor of feeding it to the stokers. In other words, the coal must be properly sized and automatically fed to the stokers, so that the operators have only to look after the stokers and endeavor to operate them at their best efficiency, and each operator must have no greater number of units to look after than he can properly operate, or the maximum efficiency will not be obtained.

A combustion engineer of a large corporation, operating quite a number of power plants says (referring to Murphy type stokers): "It is safe to say that in a mechanically-operated plant, using one man to fire two boilers, the fuel efficiency would be enough greater than when operating with one man for three boilers, to more than offset the extra cost of labor, and in either case the fuel efficiency would be better than in a plant where each fireman had to shovel coal into the stoker hoppers, as this work is so heavy that the actual working of the fires would be neglected, and the fires would not be kept in proper condition for their efficient operation.

"This question of fuel economy is an important one and it has been proved that with poor firing, with this type of stoker, the boiler efficiency may drop below 60 per cent; but with good firing it is possible to operate at 70 per cent, or even better, this difference in efficiency being equivalent to a saving of 15 per cent in the amount of fuel used. It would certainly be safe to count on at least 5 per cent lower fuel consumption in a mechanically-operated plant. On a basis of 36,000 tons of coal per year, this would mean 1800 tons of coal saved, which, figured at a cost of $3 per ton, would be a saving of $5400 per year.

"Another very important point in the elimination of the labor of breaking up the coal and shoveling it to stokers is, that it is possible to get and keep good firemen when the coal is fed by gravity to the stokers, but it is practically impossible to get such men to heave coal almost continuously up into the stoker hoppers. This is being constantly proved by actual experience."

Labor Saving

The following table of comparison of costs refers to a boiler room arranged for six 400-hp. boilers set in batteries of two each, and one additional battery of two 300-hp. boilers. This makes a total of 3000 rated horsepower. While probably not more than 6 boilers would be in operation at one time, it is figured that the boilers would be run at 125 per cent of rating. This would mean that the actual horsepower would be about 3000 and the amount of coal used would probably run in the neighborhood of 100 tons of coal per day. The stokers are taken as the Murphy type and it is assumed that there would be one stoker operator for each boiler where the coal is shoveled to the stokers and one operator for each two boilers where the coal is delivered by gravity. The wages of the stoker operators are assumed at $25 per week, and the wages for ordinary labor for handling coal and ashes at $14 per week.

For the first equipment, trestle is supposed to be close alongside the boiler room so that the coal can be stored on the ground underneath, and then wheeled into the boiler room, the lumps broken by hand and the coal shoveled to the stokers. In this case there is an allowance made of two men for wheeling the coal and ashes on each shift. With the second equipment the boiler room is supposed to be equipped with coal and ashes handling machinery and a 400-ton overhead bin, i.e., about 4 days' supply, and with this equipment there is an allowance of 1 day man for operating and taking care of the conveyor and feeding ashes to it and also helping with the coal handling, and one night man at $15 per week for handling ashes. In unloading the coal from the cars, other men would be employed for helping the coal out of the cars, and the cost of doing this work is taken at 3 cents per ton in either case, including the conveying of the coal to the bin with the coal handling machinery. The cost of power for operating the machinery would probably be about offset by the additional labor in unloading the cars on the trestle when the coal had to be trimmed out from underneath the trestle by hand so as to give more room for unloading the cars.

Boiler room equipped with trestle, investment for trestle, say $5000; coal wheeled to boiler room, lumps broken by hand, and coal shoveled to stokers; amount used per year ..... 36,000 tons

	Cost per ton.	Cost per year of 365 days.
Unloading coal from cars and trimming	$0.03	$ 1,080.00
Wheeling coal, 2 men day, and 2 men night, at $15 per week		3,120.00
Shoveling coal and operating stokers, 6 men day, and 6 men night, at $25 per week		15,600.00
Repairs: 5 per cent of $5000		250.00
Depreciation: 5 per cent of $5000		250.00
Interest: 6 per cent of $5000		300.00
		$20,600.00

Boiler room equipped with coal and ashes handling machinery and overhead bin, investment for this equipment, $20,000; amount of coal used per year... 36,000 tons

	Cost per ton.	Cost per year of 365 days.
Unloading coal from cars and conveying to bin	$0.03	$ 1,080.00
Operating conveyor and feeding ashes to it, 1 day man at $25 per week, and 1 night man at $15 per week		2,080.00
Operating stokers, 3 men day, and 3 men night, at $25 per week		7,800.00
*Repairs: 5 per cent of $20,000		1,000.00
Depreciation: 5 per cent of $20,000		1,000.00
Interest: 6 per cent of $20,000		1,200.00
		$14,160.00
Yearly saving		$ 6,440.00

*It has been proved by experience that this figure is higher than necessary, and it was adopted simply as a very liberal percentage which would not be open to question.

This shows a saving of over $6000 per year on an additional investment of about $15,000, and this comparison of machinery equipment is made against a trestle where the unloading of the coal is comparatively easy, so that the saving comes simply in the mechanical handling and crushing of the coal, in the gravity feed to the stokers and in the handling of the ashes by machinery. If a mechanically-equipped plant was compared with a plant where the coal is shoveled from the cars, in addition to the other hand labor, the saving would, of course, show up even better. To this saving should be added the saving in fuel, due to the more efficient operation of the stokers in the mechanically equipped plant, which, as given above, would probably amount to not less than $5400 per year.

Compressed Air for Pumping and Agitation

Detailed Description of Compressed Air Plant at Ladew Tannery. By Charles C. Phelps

ONE of the largest tanneries in its locality is the plant of the J. H. Ladew Co., located at the Lincoln Highway and Passaic River, Newark, N. J. It specializes in the tanning of sole leather and belting butts, the capacity being 400 hides a day.

Water from the city mains is used in the various departments of the plant excepting the beam house in which the initial manufacturing process takes place. It has been found by experience that water taken from a well on the premises is much better adapted for beam house purposes than the city water, as it brings about a condition of the hide substances putting them in better condition for the subsequent tanning processes. Judged by other standards, however, this water is of poor quality, which is probably due to the proximity of the well to the highly polluted Passaic River.

Formerly, the water was raised from this well by means of an "air lift" system for which the compressed air was supplied by a steam driven compressor. Recently, the plant has been converted extensively to electric drive and it was decided to install an electrically operated compressor to supply the air for pumping. At the same time the well piping was redesigned and the new plant was put in operation Aug. 14 of last year.

The natural flow of the well is somewhat limited, the pumping capacity being restricted to about 50 gal. a minute. There is, however, another well located about 1000 ft. distant, hence it will be a simple matter to operate the second well from the same compressor should the necessity for more water arise.

Compressed air is also used for other purposes besides pumping and it is expected that these uses will be extended in time, hence a compressor large enough to have considerable reserve capacity was purchased.

The well is lined with iron casing pipe 10 in. in diameter down to 80 ft. from the surface, this part penetrating soft ground. From the 80-ft. level down 320 ft. farther, the well has been drilled 8 in. in diameter through solid rock and left uncased. The discharge pipe extends into the well a distance of 317 ft. from the ground level. It is 3¼ in., inside diameter, for a distance of 160 ft. from the bottom. Here it is joined by a swedged nipple to piping, 2¾ in. inside diameter, which extends 157 ft. to the surface. The latter piping extends a further distance of 20 ft. above the ground level at which height the water is discharged into a tank. The latter is 16 ft. in height by 16 ft. in diameter.

As the column of aerated water ascends, the bubbles of air expand due to diminishing pressure. It is, therefore, in the upper part of the discharge pipe that slippage losses are greatest, not only due to the expansion of the air but also due to the coalescence of the bubbles. By reducing the size of the pipe toward the upper end, the discharge velocity is increased, preventing too rapid expansion and coalescence of the air bubbles and further reducing slippage losses by a quicker discharge, the slippage being more or less proportional to the time of discharge. The gain due to this cause more than offsets the greater pipe friction loss in the smaller pipe, increasing the overall efficiency.

Connected to the bottom of the discharge pipe is a foot piece which is known as a Size 5 "Imperial" Class "VA" air lift pump. This increases the discharge length slightly, so that the approximate length of the discharge pipe from the point of air entrance to the tank inlet is 338 ft. The air pipe, which is 1¼ in. inside diameter, is run down the well outside of the water discharge pipe, connecting with the foot piece. These various connections are shown in Fig. 1.

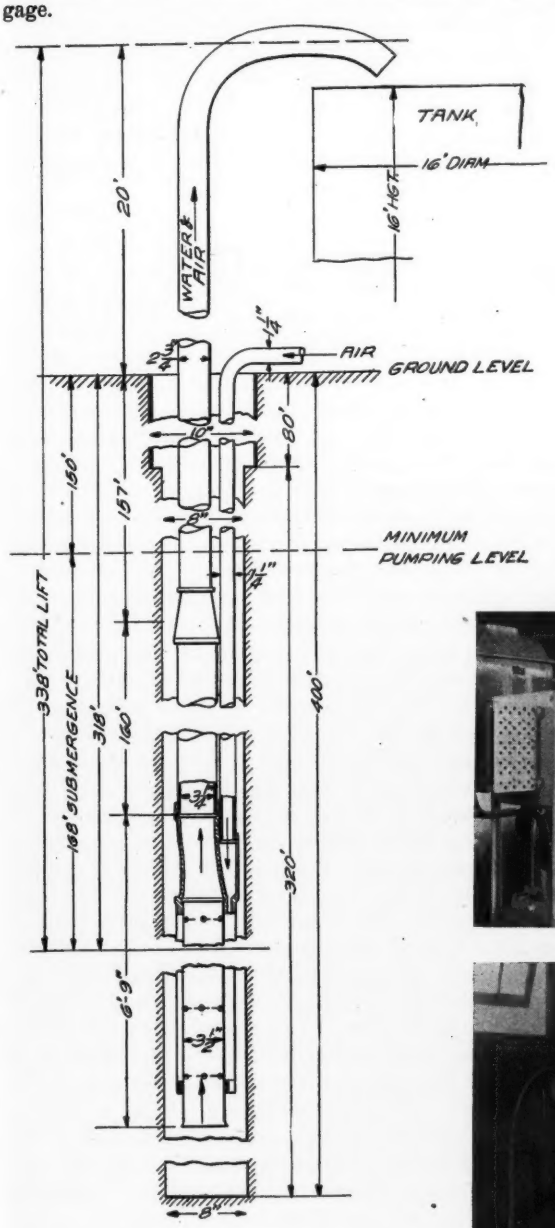
Figure 1 also shows the details of the foot piece. It consists of an outer shell or casing with an inside tube of brass, the latter having a series of rings of small holes drilled as indicated. These rings of holes are spaced in such a way as to create sufficient back pressure in the foot piece to prevent slippage losses and to regulate the admission of air to the rising column of water. The water rises between the casing and inner tube covering a certain number of the perforations, and permitting the air to pass through the perforations above. The air pressure is initially regulated by the throttle so that air will pass through a sufficient number of perforations to give maximum efficiency. Furthermore, the fine openings divide the air into very fine streams giving a highly effervescent effect to the water, which is the most efficient manner of operating an air lift. Scale, dirt, etc., that might enter the foot piece from the piping, cannot clog the perforations as foreign substances are free to pass through the unobstructed openings between the outside casing and the inner tube.

The normal water level when not pumping is practically the same as that of the adjacent Passaic River, that is a few feet below the ground level, but, when pumping, the water level falls rapidly until it is maintained at about 125 to 150 ft. below the surface. At the lower pumping level, the running submergence is 318 ft. — 150 ft. = 168 ft. and the ratio of submergence to total lift (percentage of submergence) is $168 \div 338 \times 100 = 50$ per cent approximately. An air pressure of about 125 lb. per sq. in. is required to start pumping, this air pressure exceeding the pressure of the head of water in the well. After the water is flowing freely, the normal air pressure carried at the head of the well is 70 lb. per sq. in.

The compressor plant is shown in operation in Fig. 2. It is an Ingersoll-Rogler, double-acting, single-stage machine of 8-in. stroke and 9-in. cylinder bore, operating at 250 r. p. m. The compressor is connected by short belt drive with a 25-hp. (nominal) alternating-current General Electric motor. Figure 3 shows an end view of the compressor plant; the pipe passing to the floor on the extreme left leads to the well.

The compressor discharges into an upright receiver 6 ft. in height by 36 in. in diameter, shown in Fig. 4.

An unloader keeps the pressure in this receiver between 85 and 95 lb. pressure. When the pressure reaches the higher figure, the motor is stopped and when the pressure in the receiver falls to the lower figure the motor starts up automatically. Of course, the unloader is not allowed to act while the well is starting up at 125 lb. air pressure. The air receiver pressure is indicated on the gage adjoining the receiver on the left (Fig. 4). The pipe extending to the left conducts the air to the well. Between the 2 gages on the left, the air pressure is throttled down to about 70 lb. as indicated on the left gage.



The connection below the safety valve (Fig. 4) leads to a second receiver from which air is taken for agitating purposes. This receiver, shown on the right of Fig. 3, is of horizontal type, 12 ft. long by 54 in. diameter. The problem here was to furnish a large reservoir kept full of air so that pressure might be available for agitation at any time, even though the well might be out of operation at the moment. A single large tank would require too long a period to build up sufficiently high pressure to start the air lift and, with such an arrangement, a sudden heavy demand for air for agitation might reduce the pressure so much as to render the air lift inoperative. Hence it was decided to apply a double receiver arrangement. The small receiver supplies whatever pressure is necessary for pumping and it responds quickly to the demands made upon it. The surplus air escapes to the larger receiver, gradually building up pressure in the latter.

Piping connections between the 2 receivers are shown above to the right in Fig. 4. A blank diaphragm with a 3/16-in. diameter aperture drilled in it is inserted between the 2 flanges shown here. This insures that air will not be drawn from the small tank at so rapid a rate as to interfere with the pump air supply. The air pressure in the larger receiver is indicated on the gage shown to the right in Fig. 4. The large valve beside the aperture may be closed when starting the air lift and whenever it is desired to cut out the large receiver. The small bypass valve permits filling the large receiver more rapidly, if desired. The plan of utilizing an aperture instead of a check valve was considered preferable because with this arrangement the

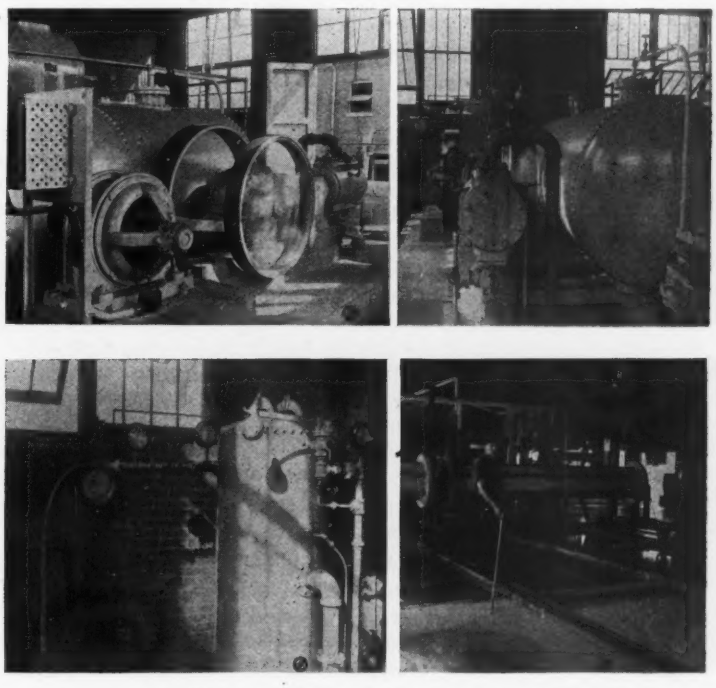


FIG. 1. WELL PIPING ARRANGEMENT

FIG. 2. COMPRESSOR, MOTOR AND LARGE RECEIVER

FIG. 3. COMPLETE AIR PLANT SHOWING END OF AIR COMPRESSOR CYLINDER

FIG. 4. SMALL RECEIVER, PIPE TO LEFT LEADS TO WELL. UPPER RIGHT OUTLET LEADS TO SECONDARY RECEIVER

FIG. 5. COMPRESSED AIR EMPLOYED FOR AGITATING SOLUTIONS

large receiver acts as an equalizer after the normal working pressure is reached, lessening the service required of the starting and stopping mechanism. As the pressure tends to build up in the small tank, the large tank takes the surplus air and as it falls the aperture permits air to return from the large tank, thus keeping the pressure range constant throughout the entire system between the limits of 85 and 95 lb. The brake horsepower required at the motor to maintain this pressure is about 23 hp. The piston displacement of the compressor is 145 cu. ft. of free air per minute, which includes air used for both pumping and agitation.

Figure 5 shows a view in the beam house which contains a great number of vats embedded in the concrete floor. These vats contain the solutions in which the hides are first immersed, preliminary to the removal of adhering flesh and hair. It is in connection with this department that the air lift water is employed. The procedure is to connect in a long strip perhaps 40 or 50 hides and then reel them upon the drum shown in the background of Fig. 5. The drum truck is then wheeled over one of the vats and the string of hides unreeled into the vat. Before immersing the hides it is necessary to agitate thoroughly the solutions so they will act upon the hides uniformly. For this purpose compressed air has been found to be excellently adapted. Several tubes, about 8 ft. long and ½ in. in diameter, connected with the compressed air supply by rubber hose, are used for agitating. Each is capped on the end and has several perforations through which the air escapes. The tube is inserted to the bottom of the vat, the air turned on, and in a few seconds, the contents of the vat have been completely mixed. Figure 5 shows how violently the solution is stirred, forming heavy froth on the surface.

The vats in the background had not been subjected to agitation, but the one in the right foreground had been subjected to air mixing but a few minutes previously and still retained a frothy covering.

Correcting Turbine Vibration—II

VIBRATION DUE TO BEARING AND OIL TROUBLES AND OTHER CAUSES APPARENTLY REMOTE. BY EUSTIS H. THOMPSON

TURBINE machinery requires a higher grade of oil than low speed machinery, and as much has been written about the various advantages of asphalt and paraffin oils, it is not necessary to enter into the subject.

The oil should stand a higher temperature than in engine practice and should not saponify or foam when coming in contact with water. The various manufacturers of turbines are always ready to furnish specifications for the required oil.

It is usually recommended in using turbine oil, to draw off the entire amount and renew with fresh oil at intervals of a few months. This will prevent trouble, in case the new oil should be of a slightly different composition than the old oil, and cause emulsing.

It has been the writer's experience that best results are usually obtained by drawing off a few gallons, or buckets of oil, depending on the amount in the reservoir, every month or so, replenishing with fresh oil. If the machine can be shut down about 12 hr. before doing this, and the piping arranged so that the oil can be drawn from the lowest point of the system, it will remove the worst quality of oil, and sediment, etc., will be eliminated, and the system kept cleaner than by the other method. The oil from a reliable manufacturer is usually sufficiently uniform in grade.

Case 9. A 300-kw. turbine set supplied most of the power for a small town. It had run for some time in good operation, but suddenly began to vibrate badly and had to be shut down. As it could not be spared from service, the operator managed to make it carry the load for a while by pouring oil by hand into a bearing that had become hot. When it was possible to take the bearing down, it was found that it had been incorrectly assembled when last taken apart, and it had worked so as gradually to close the oil supply. This was rebabbitted and worked O. K.

Some machines, especially small sizes, may operate at 3600, or 7000 r.p.m. without forced oil supply; but on larger machines, oil under pressure is generally required. On some types of machines, vibration will occur if the pressure of the oil supply drops 50 per cent. In extremely sensitive machines, high temperatures or unsuitable oil will cause the oil film to break down, allowing direct contact between shaft and bearing. This causes violent vibration. A noise and heating are usually characteristic of this trouble.

Case 10. A 1000-kw. turbine which had just been placed in operation began to vibrate badly on being started up. The shake began at about half speed, and was so serious that full speed could not be reached. As it happened that the machine absolutely had to go into service, no time could be spared for repairs. An inspection showed that most of the shake was at one end, and the bearing there vibrated badly, although no unusual heating was observed. Pouring plenty of oil in this bearing was tried, and it was then found possible to coax the machine up to full speed where operation was about perfect. A week later, when the machine was shut down this bearing was examined, and it was found that a piece of brass sheet was caught under the top half of the bearing, pinching the shaft. This proved that a tight bearing is not necessarily a cause of vibration, but tends to magnify it, as the most trouble occurred at the minor critical speed, and no vibration was present at full speed.

A loose-fitting bearing is not in itself a cause of vibration, if the other adjustments are O. K. In cases where the balance weights produce a pull through it, as in Case 7, a loose bearing should be avoided. Bearings naturally wear at the bottom, so that the shaft settles away from the top of the bearing. The writer has seen a 3000-kw. turbine giving practically perfect operation, while the middle bearing was worn 3/16 in. approximately (0.16 in.). As long as the line-up is not out too far, with other

adjustments O. K. a loose bearing should not give trouble (provided shaft fits on bottom); but with a bad distribution of balance weights, sprung shaft or "unrigid" foundation, it would cause trouble in all probability.

Bearings are made larger than the shaft by 0.0005 to 0.003 inch per inch of shaft diameter, depending on conditions required.

Case 11. On starting up a 500-kw. turbine, great vibration appeared at half speed. Greatest vibration appeared at one bearing which got very hot. It was found that the roller thrust bearing had been assembled too tightly, causing it to heat, and on giving it more clearance, the trouble was eliminated.

Thrust bearings for vertical turbines, or step bearings cause vibration trouble when the revolving block is out of parallel, or oil or mechanical faults are present. The character and conditions of vibration will indicate the cause.

Vibration Caused by Packing Trouble

Case 12. A 750-kw. turbine, when first started up, showed violent vibration at full speed. This was mostly at one end, and the shaft was quite hot, as also was the packing casing. One ring of carbon packing was found to be too small in diameter, so that it pinched the shaft. This was fitted to a diameter larger than the shaft, and the trouble was eliminated.

Case 13. After some repairs had been made on a small turbine, it was brought up to speed, and vibration developed, and a pounding noise was heard at one end. This came from the packing, where one ring was found to be jammed so that it was wedged against the shaft. On relieving the ring, it worked O. K.

When machines with metallic packing rings are first started up, this jamming action often takes place. The remedy is to turn the turbine over slowly until the packing is worn to the shaft.

In fitting packing rings, those on the outside, which separate the atmosphere from a small pressure may be fitted so as to hug the shaft and usually are so designed. The other rings, subjected to a greater pressure, should be somewhat larger than the shaft, so they can not pinch it and cause vibration, except on one or two stage machines, where the shaft is too stout. Arch bound rings, or those clearing the shaft should be 0.001 to 0.002 in. larger per inch of shaft diameter. Thus a 6-in. shaft requires a clearance of 0.006 to 0.012 in., the former if measured warm and the latter if cold.

Vibration Due to Foundation Troubles

Case 14. A 100-kw. turbo generator set, running at 3600 r.p.m., operated well when first installed; but after a while, serious vibration spells developed. This vibration varied with load, as characteristic of bad bearing alinement. Part of this set rested on a concrete block, and the remainder on steel posts. A sensitive level placed on the turbine indicated that on very hot days the steel posts would expand sufficiently to throw the machine far enough out of line as to cause vibration. The remedy was a more homogeneous foundation.

Case 15. A 500-kw. turbine set was installed and leveled O. K. Part of the foundation consisted of a block of concrete formerly used for an engine set. The remainder was a new block of concrete built for the turbine. When put in operation, bad out-of-line vibration developed. A level placed on the machine showed that the new concrete had settled considerably, throwing the greater part of the machine too low.

Case 16. A sensitively built turbine of many stages was placed on a concrete foundation that was designed so small as to be scarcely adequate. Vibration developed in the turbine, and this gradually became worse and worse until, when it was investigated, the foundation was found to be cracked and one wheel loose, as the small unbalance effect had caused a serious shake on account of "unrigidity" of the foundation allowing sympathetic vibration. Sympathetic vibration is often neglected by engineers in laying out foundations, and steel structures are often provided that need considerable bracing before being fit for a turbine. This subject is treated more extensively in my article on foundations in the number of Oct. 15, 1916.

Improper grouting is sometimes a cause of vibration. This subject is too well understood to need comment.

Vibration Due to Water and Steam Troubles

Water, coming over with the steam, does not affect small stout turbines of one or two stages beyond slowing them down, or producing a small vibration of low periodicity. In large machines, it sometimes produces a vibration that requires the machine to be shut down. This resembles out of balance vibration very closely.

In changing from condensing to non-condensing, or vice versa, the expansion or contraction of the rotor sometimes causes rubbing between moving and stationary blades.

Troubles due to acid or sediment in the steam, rust or corrosion, etc., are discussed in Case 6, as they cause an unbalanced effect.

Case 17. A 300-kw. turbine set that had been several years in service showed vibration of a variable periodicity like out of alinement, and the real cause appeared baffling. The valve gear was known to be working badly, so that the steam was not admitted according to the load requirements; but the entire steam inlet was being opened wide or closed tightly at intervals. After readjusting the valve gear to give good operation, the variable vibration disappeared. It then appeared that the blows of the steam against the buckets set up this shake.

Vibration Due to Mechanical Construction

Such troubles are notably absent from the turbine machinery turned out at the present time. The following cases were encountered and corrected many years ago, but the lessons taught are sometimes applied at the factory, or in rebuilding old or damaged machinery.

Case 18. A small turbine set gave vibration trouble that was objectionable, and which was of a variable character. On starting and especially in shutting down, noise could be heard inside the wheel casing. This noise indicated something loose, and on looking at the rotor, both wheels were found to be loose on the shaft. In this instance new shaft and wheels were supplied assembled. Loose wheels do not always cause vibration, but are active in magnifying it.

Case 19. A large sensitive turbine would operate well for a period of a few hours or days, and then take a violent shaking spell requiring it to be shut down. The shake appeared to be caused by heavy load and acted like alinement trouble. The alinement, however, was known to be O. K. and the trouble was finally located in loose construction of the built-up wheels. The wheels readily magnify vibration, and if the riveted construction should become loose from any cause, the effect will seldom remain unnoticed. With up-to-date factory methods, such a condition is practically never encountered nowadays.

Case 20. A small 2-stage turbine developed violent vibration. This was a non-condensing set, and the shake would usually appear about ½ hr. after starting up. Sometimes the machine could be heated up slowly so as to run smoothly on a light load, but seldom. Alinement and balance were fairly good. As heat seemed to be responsible, this was investigated further, and the machine could be turned over from the electrical end for any length of time without any shaking; but if steam were admitted, vibration would occur, and if the steam were shut off and cool air let in on the rotor, running would soon get smooth again. The shaft was then checked and found to run true when cold, but to be badly sprung when hot. This was really due to the action of the wheel hubs in expanding together, where machining had not been accurate. Shafts have often been located that would run true when cold, but take a spring when hot, on account of their own internal stresses. These conditions, however, are now a thing of the past.

In regard to sprung shafts, these are not usually regarded as impediments to good operation. In very high-speed machinery, having small flexible shafts, a small spring is usually expected. Springs can often be counteracted by a little balancing. In cases where fields have burned up, or generators been thrown together when out of phase, bad springs or twists are often caused, that must be eliminated in order to obtain good operation. In one case of a small turbine running 3600 r.p.m. a spring of 1/32 in. was made in shipment.

This spring prevented any operation, as vibration was so bad. The shaft was straightened so it ran out about 0.002 in. and the operation was then first class.

Case 21 was a small 2-stage turbine in good running condition. A pounding was very noticeable in the end bearing. On looking into the matter, the ball joint of the self-alining bearing was found to be too loose, allowing the bearing to work around. The matter was corrected by placing a liner over the ball joint. In most cases of looseness like this, however, no trouble is noticeable. If the other adjustments are not all they ought to be, trouble will occur.

Bearings may be loose in the bore for the shaft without causing trouble if other adjustments are O. K.; but if any are slightly out, trouble will be noticed. A tight bearing on the shaft was previously discussed in Case 10. A bearing that was too tight in the ball joint was discussed in Case 4.

Vibration caused by a flat spot in the shaft, or by eccentric coupling, is characterized by its regularity, generally at low speeds, and often by a knocking. The clue is usually the locality in which it is most noticeable.

Defects in minor shafting, gears, etc., are characterized by the locality in which they appear.

Vibration Caused by the Electrical End

Case 22. A 150-kw. d.c turbo generator set that had given first class service for years suddenly developed terrific vibration. The shake was quite evenly distributed, but increased directly with load, and very bad commutation was noticed, with a few black bars appearing on the commutator. The winding on this end was inspected carefully, but no fault could be found. When the winding on the other end was inspected, a loose joint was readily located. This was soldered up and the commutator trued up, and the trouble disappeared. The loose joint caused a vibrating flux in the armature which caused the shake. Sometimes the loose joint can only be located by means of measuring the resistance of all connections with a fairly large current. Black commutator bars are always characteristic of this trouble.

Case 23. A 100-kw. turbo alternator set was running at 3600 r.p.m. Suddenly a vibration developed that made it necessary to shut down right away. An investigation was made, and the shake was clearly in the generator end. No vibration would appear until a field current was applied. The field resistances were checked up, but as no other generator was in the station, the means were limited, and no loose joints could be located. On disassembling the field, one of the leads was found to be unsoldered in its terminal. Had it been possible to check this resistance with a current fairly large, the trouble would have been easier to locate. The vibration was caused by a variable field flux.

As before stated, a bad line-up of the magnetic elements, causing either a thrust on the shaft or a radial pull, may cause vibration in a sensitive machine; but the writer has seen many such bad line-ups without ever causing vibration.

Record Breaker for Petroleum

That 1916 was a record-breaking year for the petroleum industry of the United States is indicated in a preliminary estimate of the output of crude oil made by John D. Northrop, of the United States Geological Survey, Department of the Interior.

Mr. Northrop estimates that during the year just closed 292,300,000 bbl. of crude petroleum was produced and marketed in the oil fields of this country. This quantity is greater by 11,000,000 bbl., or 4 per cent, than the output in 1915. In addition to the quantity of oil produced and marketed in 1916, several million barrels were produced and placed in temporary field storage in Kansas and Oklahoma.

The increase in 1916 is accounted for by the continued ability of the newer fields in the Mid-Continent and Rocky Mountain regions to supply enough oil from new wells to furnish the normal decline in the older fields east of the Mississippi.

Prices of crude petroleum at the wells averaged considerably higher in 1916 than in 1915. The upward tendency of the market, inherited from 1915, persisted, with steady advances in the prices until March, when relative stability was attained.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Care of Storage Batteries

KNOWLEDGE OF REQUIRED ATTENTION, POSSIBLE TROUBLES, THEIR CAUSES AND REMEDIES
IMPORTANT FACTORS IN MAINTAINING USEFUL LIFE OF CELLS. BY J. C. HAWKINS

ATTENTION necessary to operate storage batteries successfully must be along some well-defined line, if satisfactory results are to be obtained. The room in which the battery is placed should be well ventilated and with a temperature as near 70 to 75 deg. F. as possible to reduce evaporation of the electrolyte to a minimum. The ceiling and walls should be of acid-proof material, brick or plaster being suitable. The floor should be made of concrete sloped to a drain at one point, making it possible to wash out with a hose any electrolyte spilled, or dirt which may find its way into the room. In some instances wooden floors painted with 3 coats of asphaltum paint have given good results. Sufficient natural light should be admitted to the room if possible, but any artificial light required should be electric with the wires run in rigid enameled conduit.

The arrangement of the cells should be such as to allow all to be easily accessible from at least one side. It is highly important that the cells be well insulated from each other and from the ground. A convenient arrangement of the batteries is to have wooden racks or frames made, usually about 16 in. high, unless there are to be 2 tiers of cells, in which case the lower racks are about 10 in. and the upper tier about 1½ times the height of the cells above the lower set. The racks should be made of dressed 4 by 4's painted with 2 coats of asphaltum paint. An alley 2 ft. 6 in. wide should be provided between the rows. After the racks are in place and painted, wooden trays ¾ in. deep, just large enough to hold one cell are made, with holes in the bottom for drainage, filled with sand and placed on the racks, using glass insulators as supports. The trays are placed the proper distance apart to make connections between the plates. The empty glass jars should be washed, placed on the trays and accurately leveled and lined up. As a rule the elements are shipped assembled, and after being unpacked and cleaned, may be placed directly in the jars. This must be done carefully to prevent breakage of the jars, a good way to do this where the elements are heavy being to take a strip of canvas, pass it under the plates in an upright position and by taking hold of the 2 ends in one hand and steadying the plates with the other lower it gently into the jar. Take care to see that the positive of one cell comes adjacent to the negative of the next cell. After all the plates are in place check them up to see if the connections are correct and bolt them together with the connectors provided; connect up the end cells and complete generator connections as shown in the blueprints furnished by the manufacturer.

The separators are then put in place to keep the plates from becoming short-circuited either by buckling or by sediment bridging the narrow space between them. These separators are usually made of thin sheets of a specially treated wood with dowel pins at each end to prevent breaking or buckling. These strips are dropped between the plates and may be held down by laying glass bars across the tops of the plates.

The cells are then ready for the electrolyte. It is preferable to purchase this already made up, and of guaranteed purity. If, however, concentrated acid is used in preparing the electrolyte at the plant it should be made by pouring one volume of pure sulphuric acid of 1.84 sp. gr. into about 5 parts of distilled water. The vessel used should be a lead lined tank, or for small quantities a glass or earthen jar. In mixing, always pour the acid into the water slowly, and never the water into the acid. Stir constantly.

Allow the hot electrolyte to cool before adding to the cell, as the hot acid will cause sulphating. The battery must be kept clean and the terminals coated with vaseline or paraffin to prevent the electrolyte from creeping up and corroding the cables, terminals or other metal. Corroded copper must not be allowed to get into the cells. If through accident this does occur, the electrolyte should be removed and replaced with new. Matches and exposed gas jets should not be allowed in the battery room, especially while charging, as the gases given off at that time are combustible and may explode.

In the action of the cell and especially during the summer and toward the end of a charge, some water is lost. This evaporation must be made up by adding distilled water from time to time as required to keep the electrolyte above the tops of the plates. It is usually not necessary to add acid except when cleaning or removing the sediment, at which times dilute acid of 1.200 specific gravity should be used.

In charging and discharging the colors of the plates change. The positive plate is a light brown when discharged, becoming darker in charging, and with a heavy overcharge is nearly black. The negative plate is a light slate when discharged, and becomes darker as it becomes fully charged. After becoming familiar with the particular battery, the condition of charge and discharge may be determined by the color of the plates.

The first charging should be started as soon after the electrolyte is put in as possible to prevent the plates becoming sulphated. Have all cables run and connections made beforehand to avoid delay. Care must be taken to see that the positive pole of the generator is connected to the positive pole of the battery. The first charge should be carried on for a period of 20 to 30 hr. to complete the forming of the plates, and may be at normal rate unless the temperature of the electrolyte goes above 100 deg. F., in which case the rate of charging should be reduced. The normal rate or charge will depend upon the size of the battery and is specified by the manufacturer. The voltage at the beginning of the charge will be about 2 v. per cell, rising to a maximum of 2.55 v. when fully charged. As the cells become fully charged they will give off gas freely indicating that they have been charged to their capacity, and any additional charge is only dissipated in decomposing the electrolyte, although an overcharge may be frequently required to bring up any weak cells. After the battery is fully charged it may be discharged until the voltage reaches 1.75 v. per cell, which is the lower limit except in case of a heavy discharge for a short period when it may go as low at 1.6 v. The cells should be recharged again as soon as possible. Subsequent charging should be at normal rate, decreasing slightly near the end of the charge. This insures longest life and greatest efficiency of the cells. During these charges the voltage will rise from about 1.8 to 2.5 v. per cell. When the cells become fully charged there will be little increase in voltage with additional charge, and the cells will be of a dark color and gas freely which may give them a milky appearance or they may appear to boil violently with an increase in specific gravity to about 12.04.

It is essential to keep a record of the ampere-hour rate of charge and also of the ampere-hour discharge that the conditions of the batteries may be known at all times, making an allowance of 15 to 25 per cent loss depending on the rate and frequency of charge and discharge. Once a week the electrolyte in each cell should be replenished with pure water, if necessary, and each cell should be tested with a low-reading voltmeter when fully charged; also measure the specific gravity of each cell at this time by drawing off a sample of the electrolyte into a test tube with a battery syringe. These readings should be recorded on a suitable blank, which makes it possible to compare the conditions of every cell at all times.

As the cells are constantly undergoing chemical change, one cell is selected as a pilot cell which is used to indicate quite accurately the conditions of the entire battery at all times as to the state of charge and discharge of the set as a whole. The electrolyte in this cell should be kept at about ½ in. above the top of the plates by adding a little water at frequent intervals and the voltmeter and specific gravity readings taken as the conditions of charge and discharge.

In addition to the regular charge, the battery should be given an overcharge about once every week or 2, depending on its use, for the purpose of bringing up any weak cells. This may be continued until the voltage reaches 2.65 v. per cell and the electrolyte boils freely in every cell. Sometimes it will be found that one or more cells are not working right, and are not up to standard. If the specific gravity of the electrolyte in the defective cell is normal, it may be shunted in discharging, and given an additional charge during the next charging period.

The most frequent causes of trouble are impure electrolyte, short circuits, sulphating, flaking, disintegration and buckling or warping of the plates.

Impure electrolyte may be caused by using impure water or acid or by some foreign matter getting into the cell. The remedy is to replace the electrolyte with new of known purity, while the cell is discharged.

Short-circuiting will be indicated by the voltage and specific gravity being below normal. The usual cause is sediment collecting in the bottom of the jar or by some foreign substance falling into the jar touching 2 or more plates. Cracked insulators may also be the cause. After the cause is located and removed, the cell should be given an additional charge by shunting it while being discharged until its voltage and specific gravity become normal.

Sulphating is caused by a whitish scale of lead sulphate forming on the plates. This is a non-conductor and acts as an insulator, and should be removed at once, as it greatly reduces the capacity of the battery and may lead to other trouble. Sulphating may be caused by leaving the battery standing discharged for several days by overdischarging, or by the electrolyte becoming too hot in charging or discharging or by being too strong. The over discharge may be due to short circuits. When this occurs, the plates should be removed and scraped, removing all trace of the scale. It should then be reassembled and charged at a low rate (about ½ normal) for a long time and only partly discharged until it is built up to normal condition again.

Flaking and buckling may be caused by the plates becoming badly sulphated, the result being that the active material will peel off. It may also be caused by a heavy overdischarge or long continued discharge. Flaking reduces the capacity of the cell and buckling may cause short circuits or the active material may become broken out. The remedy is to locate the cause of the trouble and remove it. The buckled plates may be straightened by placing them between pine boards and tapped lightly.

Any cell that shows signs of not working properly or is giving trouble should be shunted when discharged and attended to at once, after which it may be put into service again and brought up to working conditions without disturbing the operation of the battery as a whole.

Correction

UNDER THE SUBJECT of feed water control which appeared in the Jan. 15 issue, the description of the "S-C" regulator failed to explain clearly that the feeding was continuous. In actual operation, the disc of the control valve of this regulator moves a sufficient distance to allow enough water to flow through into the boiler to provide for the amount evaporated. The valve will be completely closed only when no load is being carried by the boiler.

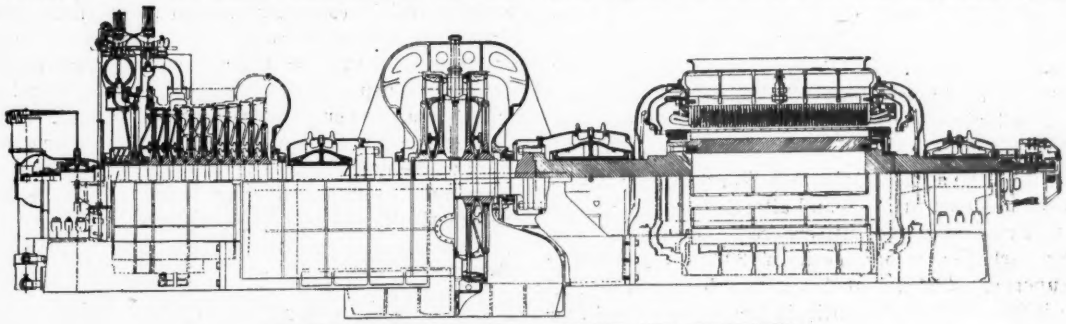
Measurements of Huge Turbo-Generator

INTERESTING DATA CONCERNING A 35,000-KW. UNIT

TOUCHING upon the development of the modern large-sized turbo-generator, the measurements of the Philadelphia Electric Co. 35,000-kw. turbo-generator, a sectional view of which is shown in the accompanying illustration, are of unusual interest.

Overall dimensions of this unit are: Length, 63 ft.; width, 22 ft.; and height, 16 ft. In order to secure a substantial foundation on bed rock for this huge machine which weighs 600 tons, approximately 600 cu. ft. of rock and earth were excavated. The foundation contains 123,200 lb. of steel and 706 cu. yd. of cement.

Steam at 215 lb. pressure and 150 deg. superheat is supplied to the turbine through a 20-in. line and 14 steam valves. Four bypass valves to the 4th stage are provided for overload operation of this turbine, which is of the Curtis horizontal impulse type having 13 stages, 11 high-pressure single flow stages and 2 low-pressure double flow stages. In the rotor a total of 8230 buckets are provided, while the stator contains 248 buckets.



SECTIONAL VIEW OF LARGE TURBINE AND GENERATOR

Operating at its normal speed of 1200 r.p.m., the low-pressure rotor wheels, 11 ft. 8 in. in diameter, have a peripheral speed of 8.34 miles per minute. At full load the steam consumption, based on guarantee, is 441,000 lb. per hour, and the most economical performance of the turbine is 11.9 lb. steam per kw-hr. when operating with a load of 25,000 kw., with back pressure in the exhaust chamber not more than 1.5 in. of mercury absolute.

Speed regulation is obtained by means of a hydraulic governor, and for a variation of 17,500 kw., ½ the rated load, the speed is guaranteed not to exceed a change of 2 per cent. The emergency trip at the throttle acts at 8 to 10 per cent above normal speed.

Main bearings are 24 in. in diameter and 54 in. long, cooled by a supply of 100 gal. of water a minute, which flows at a minimum pressure of 20 lb. per square inch through pipe coils embedded in the bearing metal. Lubrication of the bearings is cared for with 40 gal. of oil per minute, which is circulated at a minimum pressure of 30 lb.

Producing 3-phase 60-cycle current with 13,200 volts per terminal, the generator armature has 90 slots with 4 conductors in each slot. Each coil winding consists of 36 0.9 in. by 0.15-in. strands of strap copper making 2 complete turns, the approximate length of the average turn being 350 in. The length of the armature core is 10 ft. 5 in. with an inside diameter of 5 ft. 8 in. The air gap is 1⅝ in., armature having 63 air ducts ½ in. wide. Armature ventilation is provided by 85,000 cu. ft. of washed air per minute.

Copper conductors in the armature weigh 10,432 lb., the total weight of the completed armature being 100 tons. The revolving field has 14,378 lb. of copper and total weight of 66 tons, making the weight of the complete generator 166 tons.

Harnessing a Volcano

A 15,000-HP. ELECTRIC POWER HOUSE USES VOLCANIC STEAM FOR FUEL. BY PROFESSOR LUIGGI

THE idea of utilizing volcanic heat to drive an important electric power house of 15,000 hp. might have been considered utopian in ordinary conditions. It has, however, become a reality—and a successful one—in these hard times, when the price of coal has reached in Italy incredible figures.

The installation had this origin: In Central Tuscany, near Volterra, there are numerous cracks in the ground, from which powerful jets of very hot steam spout high in the air with great violence and constancy, bringing up boric acid and other mineral substances of less importance. These powerful jets of superheated steam are called Soffioni—the "blowers"—and have been utilized for many years in the production of boric acid and borax, and occasionally for warming the houses in the nearby village of Larderello. The larger proportion of the steam, however, is lost, having no local application, and with it is lost its very valuable heat.

Prince Ginori-Conti, president of the "Societa Boracifera di Larderello," was the first, in 1903, to try to utilize this superheated steam for the production of motive power. At first he applied a strong jet to a small rotary motor, then to a very modest reciprocating steam engine connected to a dynamo, which generated sufficient current to light part of the borax works. In the meantime he tried to get a more ample supply of steam by boring holes in the ground, lined with iron pipes, driven down to the very source of the steam, which is under a hard stratum of rock about 300 to 500 ft. below the surface. These bore-holes vary from 12 to 20 in. in diameter, and give forth steam with a pressure from 2 to 3, and exceptionally up to 5, atmospheres, and at temperatures varying from 150 to 190 deg. C. (302 to 374 deg. F.). For several years these jets have not

diminished in their capacity, nor does a new boring seem to interfere with the preceding ones, provided the distance from one to another is not less than 50 ft.

Experiments made very accurately demonstrate that each bore can provide steam at a temperature of at least 150 deg. C., and the rate from about 1000 to 2000 theoretical horsepower per hour. Encouraged by these results, Prince Ginori-Conti, in 1906, applied the steam to an ordinary steam engine of about 40 hp. The experience of several years has shown that this arrangement works well so far as the mechanical power the steam is concerned, but that the borax salts and the gases mixed with the steam—especially sulphuretted hydrogen and traces of sulphuric acid—have a corrosive action on the iron parts of the engine and are the cause of frequent repairs.

This difficulty was avoided by applying the superheated steam not directly in the engine, but to a boiler; that is, by applying it instead of fuel to an ordinary multitubular boiler, in which steam was produced at a pressure of 2 atmospheres, then passed through a superheater, and afterwards used for driving a 300-hp. condensing steam turbine, directly connected with a 3-phase electric generator, which supplies the works and the villages around Larderello. This installation had been at work quite successfully for several months when the war broke out. Then, coal becoming very scarce, and prices rising up to prohibitive limits, the possibility of using on a large scale this natural steam became very important.

Acting on the advice of the Tosi Works, of Legnano—specialists in steam turbines and alternating electric generators—Prince Ginori-Conti ordered 3 groups of condensing turbo-generators, each of 3000 kw., working with superheated steam at 1½ atmospheres, generated in specially-constructed multitubular boilers, the latter arranged vertically and with aluminum tubes, both for better utilization of the heat and better resistance to the corrosive action of the natural steam from the Soffioni. This steam, it is worth while to repeat, is used instead of combustible; it loses part of its heat in the boiler, reducing its temperature from 180 deg. C (356 deg. F.) to about 120 deg. C. (248 deg. F.), and is then utilized for the borax industries.

The steam thus generated in the boilers and used for the turbines is ordinary water steam, which on its way to the turbine passes along aluminum pipes heated outside by a current of superheated natural steam, at 180 deg. C. (356 deg. F.), and thus gets in its turn superheated to about 150 deg. C. (302 deg. F.). After passing through the turbine this steam is discharged into a surface condenser, the circulating water of which is in its turn cooled in an ordinary cooling tower. The condensed steam from the turbines is, of course, pumped back into the boilers, and thus no natural steam ever comes in contact with the turbine; by this arrangement corrosion is completely avoided. This was the real difficulty to be overcome.

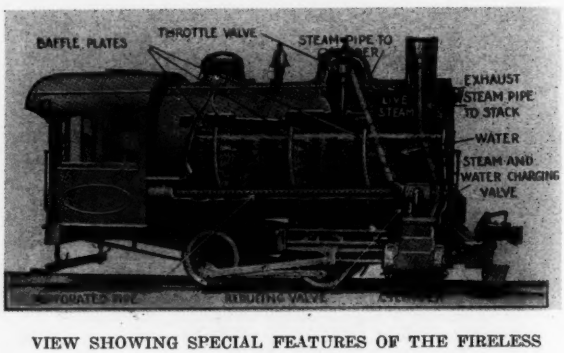
The 3-phase electric current is generated at 4500 volts and 50 cycles, transformed to 36,000 volts, and sent along aerial conductors to Florence, Leghorn, Volterra, Grosseto and many smaller towns of Tuscany, to be used principally as motive power for munition works during daytime and partly for lighting purposes at night.

One of the 3000-kw. units has been at work since January, 1916, the second since April, and the third has just been started. So far, the first 2 groups have worked quite successfully and have been a great boon to the industries of Tuscany, greatly crippled by the scarcity and high price of coal. This very successful harnessing of volcanic heat to an electric power house can be increased practically to hundreds of thousands of horsepower, as the region of the Soffioni extends for many square miles around Larderello.

Also in the "Campi Flegrei," near Naples, the ground in some parts and at depths of about 100 ft. being almost red-hot, some similar utilization of volcanic heat is already being contemplated. The Larderello power house is, however, the first, and a very important and successful example of what has been done with volcanic heat in Italy.—Engineering.

A Fireless Locomotive

EMPLOYING the principle of steam regeneration by the heat stored in the water and reduction of pressure, the fireless locomotive, now a novelty for handling freight cars in industrial plant yards, has certain advantages which recommend it as a practical competitor to the compressed air locomotive sometimes used for similar purposes. It consists of a large, round-ended tank with a false end at the front and is fitted with only such apparatus as is required for the control of the steam to the cylinders. The latter, all the driving mechanism and the outside lagging to prevent heat radiation are exactly like those of an ordinary locomotive.



VIEW SHOWING SPECIAL FEATURES OF THE FIRELESS LOCOMOTIVE

Three crosswise perforated baffle plates are fitted in the tank. These serve to prevent the water from surging from one end to the other and to prevent the locomotive from rocking.

In operation, the tank is first filled about half full of water. This enters through a valve at the front and passes into and out of a long perforated pipe extending the full length of the tank near the bottom. Then live steam from the power plant on the factory site is admitted to the tank through the same pipe as was the water. By the time the pressure between the boiler and the tank is equalized, generally at 150 lb., the water level in the tank will be raised considerably and the temperature of the water will be nearly equal to that of the steam by which it is charged, about 370 deg. F.

The steam is then drawn off through a throttle-valve in a dome in the tank top and led through a pipe to a reducing-valve in the false front end of the tank. This valve reduces the pressure of the steam to between 60 and 75 lb. per sq. in. before it is led to the cylinders. These are unusually large in diameter, giving piston area such that the locomotive can be moved with steam at a pressure of 4 lb. The exhaust steam is carried out through a pipe in the stack as shown in the illustration taken from Popular Science Monthly.

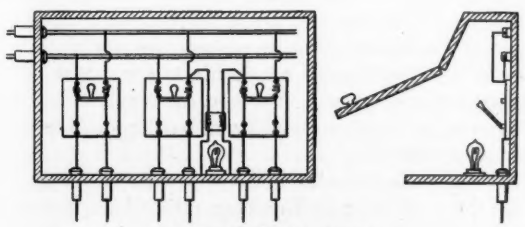
As the steam is used, the pressure in the tank becomes less and less, allowing the water to evaporate gradually and maintain a steam supply until it has been depleted to the point where it is no longer sufficiently effective.

Cabinet for Ice House or Refrigerating Rooms

By Geo. Collister

DUE to the atmospheric conditions, we had considerable trouble with corrosion of the wires and switches of the electric distribution system in a large cold storage building. Within one season, an entire circuit of No. 2 B & S copper wire was nearly destroyed and on account of this action, a No. 10 wire parted in several places.

By means of porcelain cleats, the wires were fastened high up on the side walls and any weak spot in the insulation caused the copper to be eaten away at that place; the double-pole switches and fuse blocks also suffered, becoming so corroded as to be useless.



DISTRIBUTION CABINET

To remedy this trouble, the wires were placed on the outside of the building and supported by large glass petticoat insulators mounted on iron brackets. Whenever a distribution point was reached, a tap was made and by means of conduit carried through the wall. This scheme protected the main lines and as a further precaution the switches and fuse blocks were encased in the cabinet shown in the accompanying sketch. This box was lined with asbestos board and constructed as the illustration shows in such a way that the cover always remained closed. A receptacle holding a 16-c.p. lamp was fastened to the bottom of the box and connected through a small fuse block to the line, the lamp furnishing enough heat to evaporate any moisture which might collect on and corrode the switches, fuse blocks and other metal fittings. A small peep hole furnished the necessary light for the reading of the thermometer and afforded the employes a way to locate the box. Evidently this arrangement solved the trouble, as now, after several months' use, the switches and wires are in as good a condition as when first installed.

Operating Details of Gas Producers

THE LATEST publication giving the status of the gas producer in the United States has just been issued by the Bureau of Mines, Department of the Interior, as Bulletin 109, "Operating Details of Gas Producers," by R. H. Fernald.

Mr. Fernald discusses the producer-gas-plant situation as it exists in the country today, and also compares the producer-gas plant with the steam turbine. In this connection Mr. Fernald says:

The steam turbine naturally lent itself to central-station service. It was a unit easily understood by steam-engine operators insofar as practical operation is concerned; it could be readily erected without radical changes in the boiler-room equipment; and it rapidly met the demand for large central-station units.

The producer-gas plant was an untried factor; it met with strong opposition from the older steam-plant operators, who saw possibilities of being forced out of their positions; its installation meant a complete renovation of the entire plant, with the replacing of the steam boiler by the producer unit. Large units of this type did not materialize, with the natural result that even today the producer-gas power plant is not the large central-station unit, although it occupies a strong position among the isolated plants and the small central stations.

Methods of operation vary greatly with local conditions and especially with the personal inclination or opinion of the plant superintendent. This variation is, perhaps, perfectly natural, owing to the newness of producer-gas power, the absence of experienced producer-gas engineers, the absence of co-operation among the operators of these independent isolated plants, and the absence of well-defined commercial investigations.

With this lack of a common interest on the part of the owners or operators of these plants—an interest that has of late tended to place central-station operation on somewhat uniform basis—no standards for comparison of plant operations have appeared.

Appreciating the value of operating data in connection with the many problems of fuel conservation and its investigations into the use of producer-gas power, the Bureau of Mines decided (1) that an effort should be made to procure operating details from a small number of representative producer-gas plants using scrubbed gas either for power or heating purposes; (2) that primarily data from plants using bituminous coals and lignites should be sought, but that data from a few of the larger anthracite plants and the oil and wood plants should be included.

Although, as might be expected, a great deal of indefiniteness exists regarding many of the operating details, and few, if any, cost data are available, it is believed that in this bulletin sufficient detailed information is presented to provoke wholesome discussion on the part of those interested in this form of power; to stimulate responses to future requests from the Bureau of Mines, and to serve as a basis for comparison by the different operators of similar plants.

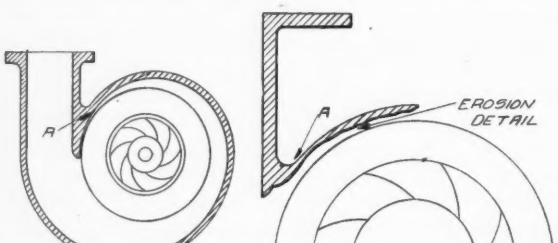
LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Peculiar Wear of Centrifugal Pump

A FLOATING gravel washing plant consisted of a 150-hp. gasoline engine and a 4-in. centrifugal pump, the pump being driven by a belt. From the inside surface of one of the flywheels a friction pulley drove through a shaft, a small centrifugal pump for cooling the unit and to provide the necessary pumping charge for the main centrifugal. From the center line of pump to deck of scow was 2 ft. 6 in., and from deck level to water level another 2 ft. 6 in., making a total of 5 ft. suction lift. The efficiency of the circulation centrifugal gradually lapsed until it was of a negligible quality, failing to provide water enough to cool the engine only, and as a consequence stalling the unit.

The pump was taken apart and a certain amount of erosion was noted on the runner, but not to the extent of rendering pump inoperative as the shaft was scored



CROSS-SECTION OF CENTRIFUGAL PUMP AND DETAIL OF WORN PORTION

and the stuffing-box was in bad shape. These were renewed at this time and joints repacked and as near as could be seen everything looked a first-class job. The pump was assembled and given a run, but the results were nil, as may be judged by the following: The pump suction was swung up through 180 deg. and the pump would not empty the pipe below the water line corresponding to the center line of the circulating pump. As all joints were tight and the friction was negligible, being practically a straight suction run with but 2 ells and a 45-deg. ell and only a few feet of 2-in. pipe, the proof was that the pump was at fault. Upon dismantling this time and making a thorough examination the pump casting was found to be eroded to an extent that merely left a shell of metal at the point marked A in accompanying sketch. Perhaps the question may arise as to the possibility of wear to that point when it would cause absolute failure of delivery. It should be borne in mind that, owing to manufacturing details, the small sets are usually allowed more metal than the large units; this allows for a greater margin of wear before holes would be eroded through the casing, which would have been the result in this case had a corresponding amount of erosion taken place on the big centrifugal. Having at last located the mystery, Professor "Oxy-Acetylene" was put on the job and the missing quantity of metal restored, dressed to shape, the cover put on, and the engine started and the pump was as good as new.

The pump, as will be noted by sketch, was of the whirlpool type of casing, center suction. H. J. G.

Proportioning Surface Condensers

I WAS much interested in the article, Proportioning of Surface Condensers, in the Dec. 15 issue of Practical Engineer, and having had considerable experience, mostly on an ocean-going steamship, and having devoted much time and study to the subject I will give readers the benefit of results obtained.

The efficiency of a condenser depends on the mean difference of temperature between the exhaust steam and the circulating water, as well as on the extent of the cooling surface. If the cooling surface is made small, the difference in temperature will be proportionately large, and to maintain the same temperature with the small surface the velocity of circulating water through the tubes must be greater, the general result being the discharge of a greater quantity of cooling water at a lower temperature.

If we circulate a small quantity of water, the temperature of the condenser and corresponding back pressure will, of course, be greater. If the condensing tube surface is made large, the quantity of water and capacity of circulating pump less, the general result is the discharge of a smaller quantity of cooling water at a higher temperature. To keep the temperature of the condenser constant, while condensing a given quantity of steam with cooling water at a given temperature, the amount of water should be approximately, inversely proportional to the condensing tube surface. The first foot of tubes through which the water passes being the most efficient condensing surface, each succeeding foot is less and less efficient, this fact makes the calculation of proper condensing tube surface to condense a given amount of steam more difficult.

The average cooling surface required will depend on the quantity of steam to be condensed, temperature of the steam, vacuum or minus pressure in condenser, and the difference in temperature between the steam and the average temperature of cooling water, which equals the initial temperature plus discharge temperature divided by 2.

The running conditions of engines and temperature of condensing water at different seasons and in various

latitudes are so different that it is advisable in fixing proportions to use round figures which have been obtained from practical experience rather than to attempt a more theoretical calculation involving temperatures, etc.

We may, however, obtain fairly accurate results as follows. Supposing we are required to design a condenser for an engine developing 7000 i.hp., with auxiliary engines and pumps, 16 lb. weight of steam will be required per i.hp. developed by main engines, per hour = 112,000 lb. to be exhausted to the condenser per hour. In steamship practice, it has been found that one square foot average condensing tube surface will condense approximately 12 lb. of steam per hour with cooling water entering at about 75 deg. F.; 112,000 ÷ 12 = 9333 sq. ft. condensing tube surface will be required, or, 9333 ÷ 7000 = 1.33 sq. ft. per i.hp., ¾-in. tubes being mostly used for ocean steamers, are 2.3562 in. in circumference. $\frac{9333 \times 12}{2.3562}$ = 47,532 ft. effective length of all tubes required. Steam at maximum absolute terminal pressure in L. P. cylinder of 15 lb. contains 966 + 212 = 1178 units of heat per pound weight of steam to be exhausted to condenser and to be condensed at, say, 24 in. below atmospheric pressure, or 24 in. vacuum. $\frac{30 - 24}{2}$ = 3 lb. absolute pressure in condenser, which corresponds to 141.6 deg. F., temperature.

1178 — 141.6 = 1036.4, say, 1036 units of heat per pound weight of steam must be abstracted from it and is carried away by the condensing water discharge overboard; that is, 1 lb. of steam when it is condensed will raise the temperature of 1036 lb. of water 1 deg. F. Each pound of condensing water can only absorb one thermal unit in raising its temperature one degree. Assuming the maximum temperature of sea from which the water for condensation is taken to be 80 deg. F., and to leave the condenser at 110 deg., the condensing water being heated from 80 to 110 deg., each pound will take up 110 — 80 = 30 units, and the number of pounds required to absorb 1036 units liberated by the condensation of one pound of steam will be 1036 ÷ 30 = 34.5 lb. of water required to condense one pound weight of steam at above temperature and pressure, or

$$\frac{1178 - 141.6}{110 - 80} = 34.5, \text{ say } 35 \text{ lb.}$$

112,000 × 35 = 3,920,000 lb. condensing water will be required per hour = 65,333 lb. per minute ÷ 64 = 1021 cu. ft.

65,333 ÷ 8.33 = 7843 gal. of cooling or circulating water required per minute.

For the above temperature of sea water, the area through condenser tubes should be such that the flow of water through them does not exceed 200 ft. per min. with initial temperature of circulating water at 60 deg. the flow through tubes may be reduced to about 110 ft. per min. and considerably less water will be required to condense the same quantity of steam.

We must have $\frac{1021}{200}$ = 5.1 sq. ft. = 734.4 sq. in. sectional area through tubes in each compartment, or group; condenser to have 2 compartments, the tubes to be divided into 2 groups.

47,532 ÷ 2 = 23,766 ft. effective length of all tubes in one group. Area through ¾-in. tube = 0.307 sq. in. $\frac{734.4}{0.307}$ = 2392 tubes will be required in each of the 2 groups to give sufficient area for circulating water.

Length of tubes between tube plates would therefore be 23,766 ÷ 2392 = nearly 10 ft., in practice one would make them 12 ft. long. Spacing the tubes at 1⅛-in. pitch, the area covered by each group $\frac{2392}{1.125}$ = 2126.2 sq. in. = 14.7 sq. ft.

H. J. TEIPER.

Corliss vs. Poppet Valves

I HAVE READ with interest J. C. Hawkins' article in the Jan. 15 issue on the above subject, and am of the opinion that he is in error in several statements.

For instance, in the second paragraph of his article he states that the steam consumption of simple Corliss engines operating noncondensing with 125 to 140 lb. steam pressure is as low as 22 lb. per i.hp. I think he will find that 25 to 27 lb. of steam per i.hp. to be nearer correct. Mr. Hawkins refers to a cross compound uniflow engine of the Nordberg Mfg. Co. I think he will find that uniflow engines are not made with more than one cylinder. In regard to the double-beat poppet valve not being as efficient as the single-beat valve, this in my opinion is not the case, as practice has never proved it to be so. I believe that the double-beat valve is a success in every respect. I think the statement that Germany has produced a uniflow engine that will develop a horsepower on 6 to 8 lb. of steam is also a little out of line. It is true that the Germans have been very successful with their uniflow engines; at the same time, to obtain a steam economy of 6 lb. per i.hp., will require some very ideal conditions.

I think he will find that a Skinner engine of the uniflow type will do much better than 17 to 18 lb. of steam per hour per horsepower when operating condensing with 145 lb. steam pressure. I think he will find the steam consumption to be nearer 14 than 17 lb. per i.hp.

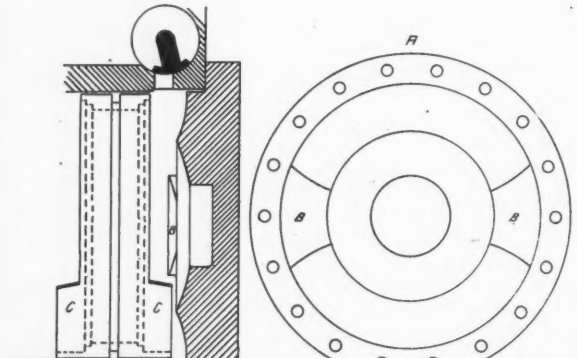
If Mr. Hawkins will look up the steam consumption curves on different types of 4 and single-valve engines, both simple and compound condensing, he will find when comparing these curves with the curves of the uniflow engine, either condensing or noncondensing, that the uniflow curve, from one quarter load to full load, is much more attractive than the former. C. T. BAKER.

Precautions When Making Engine Repairs

WHENEVER, on large engines, in making the taper fit on the piston rod where it enters the crosshead, or when from other causes such as smoothing up a badly worn or corroded rod, it becomes necessary to turn the rod and the piston around inside the cylinder, before admitting steam to turn the engine over, the cylinder

head should be removed in order to see if the junk ring has turned around with the piston.

Two instances have come to the writer's attention where this precaution was not taken. In one of these the result was a broken piston and follower plate. In the other case no serious results followed, since the rod had not been finally keyed up. When the piston and the rod are turned, the junk ring is likely to turn with it more or less. If it does so, unless it makes an exact half or full turn, the projecting shoe, which in its normal position at the end of the stroke slides into the bottom recess of the cylinder head, will strike the unrecessed



JUNK RINGS WITH EXTENDED SHOES

part of the head before the end of the stroke is reached, with almost certain damage to some part of the engine.

C. A. J.

[The type of junk ring here referred to is that as shown in the accompanying illustration with extended shoes at the bottom. Many of the engines operating in the textile mills of New England are said to be equipped with junk rings of this form.—Editor.]

Comments on Oil-Burning Plants

I WAS MUCH INTERESTED in Mr. Montgomery's article in the Dec. 15 issue, but there are some things in it with which I disagree. First is the statement on page 1021 that about all there is in efficient firing of fuel oil is the regulation of the dampers to conform to the varying loads. It is true that the regulation of the dampers plays an important part, but it is no less important to maintain clean flues, and to have the oil enter the furnace thoroughly atomized. It is also important that the burner be set so that the oil is thrown well into the combustion chamber, without striking either the boiler or its setting. The writer experienced a material saving at one plant by removing a portion of the bridge wall, which had been left when the change was made from coal to oil.

It has also been my experience that the temperature at which the oil is delivered to the burner is of more than minor importance. It would seem that 135 deg. F. is rather a low temperature for delivering fuel oil. The writer recommends at least 180 deg. F., as the oil is much more easily atomized when at a higher temperature.

All of the foregoing points have doubtless been given attention in the plant under discussion, but some engineer facing the problem of burning fuel oil, will soon be changing back to coal, if he attempts to do the thing by means of his dampers.

While the report of this plant shows a low cost per kilowatt-hour, it should be remembered that this cost is hardly figured on a commercial basis. By its military method of figuring expense, this plant is able to show a low cost per kilowatt-hour, while its fuel consumption of 0.84 gal. or 6.4 lb. is abnormally high.

An evaporation of 14.4 lb. per pound of fuel oil is shown in this report, which is fair; but with 6.4 lb. of fuel per kilowatt-hour, this plant evaporates 92 lb. of water to produce a kilowatt-hour; this is nearly 3 boiler horsepower for 1 kw.-hr. Many plants are putting a kilowatt-hour on the switchboard for 1.25 boiler horsepower, and even better; and some of them are doing this without even the use of the rotary valve. J. M. Row.

Boiler Inspection

THE COMMENTS on R. C. Packingham's subject, entitled, Boiler Inspection, pages 125 and 126, Jan. 15 issue, put me in mind of the following which happened about 2 yr. ago. Here is where I can say a good word for the inspector, despite the usual criticism against him.

The plant consisted of 2 double-drum type B. & W. boilers, with inclined tubes and vertical headers. A new header had to be put into No. 1 boiler and after having replaced the old with a new header and administered the cold-water hydrostatic test, the boiler makers pronounced the boiler O.K.

This happened to be on a Saturday afternoon and who should come in shortly after the departure of the boiler makers, but our much-talked-of boiler inspector. The chief told him what had been done, whereupon Mr. Inspector straightway started to work. On opening the boiler, he measured the flare of the tube ends in the new header and pronounced them unsafe for working conditions, as the flare was not great enough. The Massachusetts law calls for not less than ⅛-in. over the tube hole on water-tube boilers.

Our chief dug out his expander and our esteemed friend, the boiler inspector, soon had those tube ends flared to proper size.

Here also was a case where the engineer was a bit weak in getting caught by the inspector, with the tube ends as they were and not saying anything about the matter.

This inspector was from a reputable insurance company and was always thorough in all work I have seen him do. I never have known him to miss testing the steam gages while at the plant and those who work on B. & W. boilers know you have a climb ahead of you to get at the gages.

B. L.

I HAVE READ with interest the discussions of late on the subject of boiler inspection. It does not appear to me that the criticism is well founded from the point of view taken by Mr. Packingham, if it is meant for criticism; he states, however, that it is not.

He must always consider that the boiler inspector is only human the same as the rest of us, and is liable to make mistakes; but we must not condemn him until we

know that he deserves criticism. As a rule, the boiler inspector will be friendly if the engineer will show a little congenial spirit and not aim to have a grouch every time a boiler inspector comes on the job. The boiler inspector is the engineer's friend. He is always willing to give any information the engineer wants if he is received in the proper spirit. I always am glad to see the boiler inspector come. If there is anything that I don't like, I call his attention to it, as that is what he is paid for—to inspect your boilers and see that they are in a safe condition. After each inspection I always take time to have a heart-to-heart talk with him and this is generally what is said.

"Well, Mr. ———, your report is all right; but I want first-hand information as well. What did you find? If you discovered anything, I want to know it. Are there any recommendations?"

The boiler inspector examines hundreds of boilers a year; he is experienced along inspection lines and frequently discovers defects that the engineer overlooks. Besides, there are companies that will make no repairs on a boiler until they are forced to by the insurance company, although concerns of that kind are few. No one will refuse to make things safe if they realize the danger of defects in steam plants.

If I had pipes in a plant under my charge that I could puncture as easily as Mr. Packingham says he can, and had any extra pipe around, I would not be long in replacing them. If I had no material, I would report the condition to the management immediately. If they thought that I did not know what I was talking about, and placed more confidence in their judgment in such matters than in mine, I would tell them that I did not need to work where criminal negligence was practiced.

Give the boiler inspector your hand and assist him all you can; he is paid to guard the lives of you and your fellow workmen. The majority appreciate his value. BENNETT STORY.

Operation of Condensing Engines

ACCORDING TO the statement of O. H. H., appearing on page 893 of the Oct. 15, 1916, issue, it may appear as if at all times it is necessary to start condensing engines condensing, and as this may be somewhat misleading, I would like to say that in regular operation we are starting condensing engines noncondensing.

In our plant we have a 600-hp. tandem compound condensing engine direct connected to an ammonia compressor and belt connected to a 160-kw. generator. All pumps—steam circulating, dry air and ammonia circulating—are run by motors supplied with current from this machine.

The way we are situated, it is impossible for us to start the above-mentioned engine condensing. Our usual procedure is to open the atmospheric valve and start the engine noncondensing; when the engine is up to speed, we place the load on the large generator and then start the forced injection and dry-vacuum pumps and steam circulating pumps as soon as we have enough water in the hot well. Then, as the vacuum is being established, we close the atmospheric valve, and when sure we have enough water in the condenser, we shut off the forced injection.

It may be advisable to warn against working the forced injection too hard when starting up, as in doing so there is a liability of the high vacuum drawing water into the engine. Be sure to shut off the forced injection after everything is started, for if this is not done and, for some reason or other, it is necessary to stop the engine, there is again a possibility of the engine being caused to get a dose of water when the exhaust valve opens. With a sufficiently long tail pipe on a barometric condenser, and the forced injection shut, there is no liability of getting water over into the engine.

When starting a dependent jet condenser, we start in about a like manner, being sure that the vacuum pump is running at the proper speed, and being very careful about the forced injection. Most engines are made to be run condensing or noncondensing. Never forget the danger of water in stopping and starting condensers. In a barometric condenser installation, be sure that the exhaust pipe is drained of water. Some condensers are equipped with vacuum breakers that will let air in if water in condenser gets too high.

CHAS. MAGNUS.

Remedy for Broken Gland Studs

I WAS TROUBLED with the studs of the packing gland on the water end of one of our flushing pumps breaking frequently, due to the friction of the packing on the rod. This would bend the gland on the outward stroke, as shown in the illustration. This, of course, caused the studs to break. To overcome this trouble, I removed

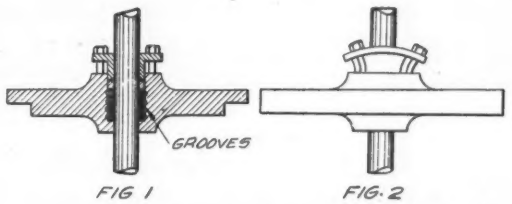


FIG. 1. STUFFINGBOX SHOWING GROOVES
FIG. 2. BENDING OF GLAND SHOWN EXAGGERATED

the cylinder head and turned small grooves inside the stuffing box, as shown in Fig. 1. This checks the packing from moving, and the gland nuts do not have to be set up only by hand now to keep the rod tight. C. H. W.

FOREIGN TRADE OPPORTUNITIES are given by the Bulletin of the Bureau of Foreign and Domestic Commerce as follows:

In Hawaii a company desires to receive catalogs, prices, terms, etc., on marine motor engines for heavy-weather service, from 5 to 20 hp., 2 and 4 cylinders, suitable for gasoline and lower grade fuel. These motors must have reversing clutch, bronze propeller and shafting. The number of this item is 23,514, and full information can be obtained from the Bureau, Washington, D. C.

A merchant in an insular possession wishes to make connection with American exporters of second-hand machines, including lathes, electric motors and woodworking machinery, quotations to be made f. o. b. New York, and cash paid with the order. The item is 23,519, full information being available from the Bureau.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Low Water—What Would You Do?

I WOULD be pleased to have some of the readers discuss the following questions:

If the water disappeared from sight in the gage glass of one of a battery of boilers and the pump was running, what would you do? Why?

If the pump was not running? Why?

What would you do if this happened in the case of a single boiler? Why? C. S. W.

Automatic Water-Level Regulation; Heater Trouble

IN THE PLANT where I am employed we have 5 72-in. return tubular boilers on which there is at times an exceedingly heavy pull when certain departments demand steam. I wish to obtain some kind of apparatus to regulate the water level in these boilers automatically. Would a governor on the (duplex) feed pump do the work?

I also have considerable trouble with pounding in a Blake-Knowles open heater used to heat the feed water from about 65 to 200 deg. F. Might this be caused by the heater being too small for the amount of exhaust delivered to it? G. I.

Corliss Valve Lubrication Trouble

I WISH to ask the readers of Practical Engineer to give me their opinion on the following matter: The steam valves on my 18 by 42-in. condensing engine, which runs at 83 r.p.m., rub and groan on the valve end side; the tee head does not touch the valve bonnet, as I have placed a collar on the outside to hold them away. They do not show any wear, but seem to be in excellent condition, are steam tight and drop easily.

Although I am using a high quality of oil and find a good coating on them at the end of the week, I find it necessary to use an excessive quantity.

What can be the cause of this rubbing and groaning of the valves and the necessity of using so much oil?

P. H. W.

Engineers' Qualifications in Massachusetts

IN REGARD to the questions of L. B., page 129, Jan. 15 number, as to the necessary qualifications for a third-class engineer in Massachusetts, I wish to submit the following:

In the first place, it would be advisable to state the qualification required by law and the law as it applies to third-class engineers' licenses.

The engineers' and firemen's license law in part says: To be eligible for examination for third-class engineer's license, a person must have been employed as a steam engineer or fireman in charge of or operating boilers for not less than 1½ yr., or he must have held and used a first-class fireman's license for not less than 1 yr.

Third-Class Engineer: To have charge of and to operate a boiler or boilers not exceeding in the aggregate 150 hp., or a steam engine or engines not exceeding 50 hp. each, or to operate a second-class plant under the engineer in direct charge of the plant.

Knowledge of the following is required of all candidates, the questions being varied to suit each examination: Setting the valve of slide valve engine; setting the valves of the riding cutoff valve engine; regulating the safety valve; valves and operation of steam pumps (from actual engines). Questions in general on engines, etc.; governors; safety stop motions; speeding; changing speed; and action. Boilers: Joints; bracing; defect in; low water; tube burst; removing tubes; replacing tubes; types; practical questions on the various types in use in the state; laws in regard to; setting; repairs; and operation. Pumps: Types; repairs; valve setting and operation; defects; and practical questions in regard to these. Feed-water heaters: Types; defects; repairs; installation and operation. Safety valves: Changing blowoff pressure; regulating blow-back; installing; defects in; laws in regard to; practical questions relative to certain accidents and conditions. Fusible plugs: Types; laws in regard to; locations in various boilers; Massachusetts standard; distinguishing various plugs from a lot of several submitted. Boiler settings: In general; specific for various types and sizes of boilers; practical questions on defects or accidents such as boilers settling, strains set up, correction, etc. Stay bolts: Drilled; hollow; Heine boiler; pitch of vertical boiler; locomotive type of boiler, etc. Corliss valve gear: Questions on setting; governors; testing safety stop motion; compound engines; shaft governors; setting valves; adjustments; taking up wear; clearance; repairs; lining up engines; general questioning as to duties when taking charge of a plant; engines; boilers; condensers, etc. Superheaters: Steam gages; water column; and all boiler room fittings and boiler attachments.

In general, the examination is to bring out the applicant's total knowledge of steam engineering and his special knowledge in regard to the types of boilers, engines, and so forth, with which he has had experience. The examination is thoroughly practical and in this grade of license a highly technical or theoretical knowledge is not necessary; in fact, few, if any, of the questions are of a theoretical nature. It is only in the higher grade of examinations that theory or technical knowledge is required. EDWARD C. DOLAND.

REPLYING to the inquiry of L. B. on page 129 of the Jan. 15 issue, I wish to state that men receiving Massachusetts licenses are only those capable of safely and efficiently handling a plant corresponding to the grade of license sought. The examiners are, as a rule, fair-minded men of many years' experience and able to recognize the strong and weak points of an applicant; they ask no more than necessary to determine the applicant's qualifications.

As to what may constitute technical questions depends on one's point of view. When asked to describe conditions under which scale will accumulate over the bridge wall in a boiler, when required to use reason, and still not be in a position to see the actual conditions in operation, the questions may be considered practical. Questions involving mathematical calculations are usually looked upon by engineers of a technical nature.

The writer's daily work brings him in contact with engineers holding all of the various grades of licenses issued in the state. He encourages them to talk of their examinations and has not learned of a single instance where the applicant for a third-class license was asked problems more difficult than to calculate the horsepower of an engine or the pulley diameters necessary to change the speed of a throttling engine.

1. The proper way to find the thickness of boiler plate under conditions outlined may be said to be thus: Carefully clean the pitted or corroded surfaces and compare the depth of the depressions with one another, using your own good judgment to determine which is the deepest. A gage termed a depth gage may be used to determine the greatest depth of pitting. Having found this, drill a hole at that point and caliper the thickness of the plate.

After taking the measurements, the hole may be filled by a rivet or tapping and putting in a screw plug.

2. The condition described in the question would seem to indicate that the boiler was out of place, due to settling of its foundation or setting. Should an examination show that the boiler had settled, it must be reset; should only the wall appear to be affected, it must be rebuilt.

In all events, the boiler should be cut out of service until exact conditions may be ascertained and repaired.

3. As Corliss valve gears are generally laid out, any appreciable forward movement of the eccentric on the shaft will result in a decrease in speed of the valve action due to the position of the eccentric in relation to the crank travel.

The eccentric is in reality a crank, and due to the angularity of the rods in transferring motion from the eccentric to the valves they are subjected to the influence of the rod's angularity and the fact that as the dead center is approached the motion is slower.

RECEIVER.

SO MANY replies having been received to the inquiry of L. B., in the Jan. 15 issue, that space will not permit publishing them all in full. We are therefore presenting only the more important points brought out in these communications.

According to the letter of E. L. K., each examiner follows his individual line of questioning and usually asks leading questions which open the way to discussions whereby he may readily determine the applicant's knowledge of the subject in hand. The examination is entirely verbal, and no mathematical calculations of any consequence are introduced; the applicant is, however, required to show his ability along that line by setting valves on pumps and small engines provided for the purpose.

C. M. states that the applicant shall have held and used a fireman's license for not less than 1 yr. or be able to prove to the satisfaction of the examiner that he has been working around boilers and engines a year or more. He must have a good knowledge of the construction and operation of the various types and makes of steam boilers and their appurtenances such as the water columns, safety valves and steam gages; ability to explain the various arrangements and connections on crossheads and cranks and the effect of keying up on them, to line up engines and to remove and replace pistons and piston rings. He should also be able to exhibit a fairly good knowledge of the action of throttling and automatic cutoff governors, and their respective advantages and disadvantages, and to explain the theory of operation of pumps and injectors.

Perhaps one of the most important things to be able to tell the examiner is what to do in case you discover scale or oil in your boilers or such defects as pitting, bags, blisters or leaky tubes and seams.

In answering the first question of L. B., W. E. R. recommends practically the same procedure as given by the others; namely, that of drilling a hole in that part of the boiler shell in contact with the hottest gases and noting the thickness of the sheet at that point. He, however, advises that when plugging this hole, care shall be taken to have that part of the plug extending inside the shell flush with the plate, so as to prevent the possible accumulation of scale which might otherwise form over and around the plug, resulting in a bag.

Relative to the effect produced by advancing the eccentric of a Corliss or slide valve engine, W. E. A. states contrary to the opinions expressed by others, but correctly so, that this will neither increase nor decrease the average speed of the valve; the only effect shifting the eccentric will have, is that of advancing or retarding the events, depending upon whether the eccentric be shifted forward or backward.

A number of lists of typical examination questions asked applicants for third-class engineers' licenses in the state of Massachusetts have been received in compliance with the request of L. B. These, together with answers, will be published in subsequent issues, space not permitting their publication at the present time.

A Troublesome Bearing

WHO CAN OFFER F. H. a remedy for the trouble he is experiencing?

He has charge of a generator direct connected to a Ball & Wood engine and states that so much oil is finding its way out of the bearing next to the coupling that it creeps along the shaft and is thrown into the armature winding.

Have you ever had such trouble? If so, how did you overcome it?

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Assembly Plans of Piping

In very large power plants the space occupied by piping is so important a factor in the station construction that it pays to prepare the plans for this part of the work with more than usual care. Formerly piping drawings, if made with any completeness whatever, exhibited in many cases a degree of complication that was the despair of the outside engineer studying the details of the installation. It is good to see this lack of attention to a really vital feature of station design passing away, as the value of clear-cut and comprehensive drawings is more and more appreciated.

As in the field of station wiring, there is a real place for the schematic diagram in piping layouts, and more work of this kind may be expected in the future than we have seen in the past. The symbolic representation of piping and valve locations by simple straight-line and cross-marked diagrams is an easy matter and its cost in the drafting room so small that it may properly be added in installations where such explanatory information makes the working drawings clearer. The contractor handling a complex layout needs the detailed working drawings which have become common in recent years; but in the latest work, the best engineering organizations today are going a step farther by adding accurate assembly plans and elevations to the working drawings of separate systems. In one large station now under construction, these assembly drawings have proved of the greatest assistance to the resident engineers, who thus save time and avoid the overcrowding sometimes arising from sufficient appreciation of the exact space requirements of each independent piping system.

Assembly plans of piping, like other so-called "general" drawings of station equipment in place, are valuable as records and in case of alterations which must be charged in part to capital and in part to operating expense, enable pro-rating to be done with far greater accuracy than in most cases where no suitable plans and elevations are available. Engineers operating plants unprovided with such drawings might do far worse than gradually to prepare full record sheets with at least skeleton diagrams as an anchor to windward which some day or other may be useful far out of proportion to their cost in time and effort.

Public Speaking for Engineers

More and more, as engineers take part in public affairs and are given responsibility in large organizations, it becomes necessary for them to have the ability to express themselves clearly in talking to others, both in explaining technical matters and in urging the adoption of right methods and apparatus. In many schools, courses in public speaking are introduced; but for the man outside the school, the same practice can be had by speaking before his organization. We are assuming that he is fulfilling his duty to himself, his profession and the community by belonging to an organization and attending its meetings.

First attempts may result in some discouragement; but nothing worth while was ever attained without work and perseverance, and ease comes with practice.

Every man will have faults which he can correct when pointed out to him; and it will be worth the time of an organization to devote an occasional evening to this work, everybody present to speak on some subject connected with his daily work, and the others to make suggestions as to how he can improve his method of statement and his delivery.

Fundamental points for the speaker are a clear understanding of what he wishes to say; a definite order of making his points; clear statement; impressive tone and gesture free from restlessness and with all movement of body, head and arms helping to emphasize the statements; and first and last, a definite end to be sought, whether it be to entertain, to arouse, to inform or to convince the listeners.

Editorial Comments

The New High School Plant for Power, Heating and Ventilation at Cicero, Ill., which has but recently been put into operation, is a typical example of modern practice and the description given in this issue will, by contrast, bring to the minds of many the conditions which surrounded the little red country school house you attended. For the proper development of mind and body, healthful conditions must prevail, which, in large cities, are made possible only by mechanical means. A study of the equipment of this plant will give an idea of how engineering is a benefactor to the youth of the city in one important direction.

Economy in the Use of Coal is the slogan in the boiler room; how to attain it is the great problem in steam generation, but a direct practical answer to many questions on furnace operation will be found in the article by Mr. Bement in this issue which is the third and last of the series.

Coal and Ashes Handling and Storage is a subject which deserves consideration in every power plant. Mr. Edsall gives several reasons why mechanical equipment should be installed for doing this work, the article published here being the first of a series upon the subject. In following issues the various types of equipment will be discussed.

Compressed Air for Pumping and Agitation has not as yet received due consideration by engineers in charge of industrial plants. What is being done at the Ladew Tannery, as described by Mr. Phelps, represents only two of many applications for which compressed air is adapted. A study of your own plant or factory may reveal places where compressed air can be used to advantage.

Correcting Turbine Vibration is not ordinarily the work of an operating engineer, but it is his duty to supply proper lubrication and maintain bearings. Mr. Thompson relates instances where vibration was caused by bearing troubles and the operator should be familiar with the characteristics as outlined in this issue.

Care of Storage Batteries is a matter of habit with many engineers, largely because it is a chemical process which is not thoroughly understood. Following directions rather than reason cannot be the highest type of engineering, but is, of course, one step in the training. Mr. Hawkins gives some good ideas on storage batteries which can be worked into specific rules or directions for operators in any plant.

The Measurements of a Huge Turbo-Generator as given in this issue make the turbine occupy approximately as much space as the largest sizes of reciprocating engines, and the question naturally arises, what will be the next machine to economize space? Comparison of capacities, however, is vastly in favor of the turbine and it is doubtful whether concentrating so much power in a single machine is real economy, except where it represents one-fifth or less of the plant load.

Harnessing a Volcano sounds like fiction, but we are told it is an actual fact, by Professor Luiggi. Slowly, as the necessity demands, the natural resources of the earth are being turned over to the services of man.

Cabinet for Ice House and Refrigerating Rooms differs in some respects from the ordinary switch cabinet for factories, due to the presence of destructive elements. How to protect switches and wires used in refrigerating work is told by Mr. Collister.

Operating Details of Gas Producers have been needed for some time. Following the introduction of gas producers many operating difficulties were encountered which have seriously handicapped the growth of this form of power. Operators and owners will welcome the information given by the Government on this important subject.

Letters Direct from the Plant published in this issue deal with a variety of subjects, some of which cannot fail to arouse your particular interest, for each letter relates an experience or expresses an opinion of an engineer in the harness who has, figuratively speaking, had sweeny, fistula, spavins and blind staggers, but has pulled his load to the barn.

Questions Answered and for Answer are the problems of your plant and your own future. Do they mean anything to you? Well, let us hope so and you will find some profitable as well as interesting information in this department.

Practical Reference Tables for this issue present in condensed form causes for turbine vibration for quick reference in times of trouble, and by means of a chart and table an easy method of finding the contents of a horizontal cylindrical tank is given. Such data will save time if you need the information and a well kept note book takes but little space. Get the saving habit.

All Questions Signed

In many instances it is found advisable to answer questions that come to the service department by mail. Even if answered in the paper, the name and address of the writer must be given as an evidence of good faith, but will not be published. No unsigned questions can be answered.

Readers should note this carefully, and be sure to sign all letters.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Starting Switch on A. C. Motors

SINGLE-PHASE induction motors using the split-phase method of starting require a switch to cut out the starting winding. This switch is always arranged to operate by centrifugal force just before the motor reaches full-load speed.

The old type of switch operated by the centrifugal force of the contact fingers, while reliable for light service, did not meet the increasingly heavy demands put upon single-phase motors.

The new switch developed by the Westinghouse Electric & Manufacturing Co., for use on its small single-phase induction motors, has been designed for great endurance and reliability combined with simplicity.

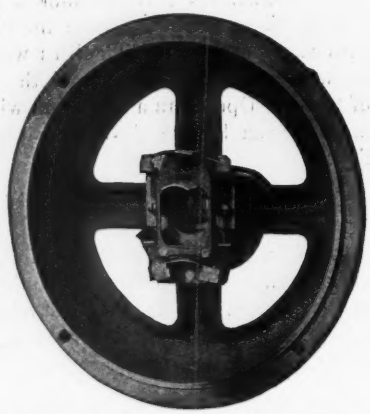


FIG. 1. STATIONARY ELEMENT MOUNTED ON MOTOR BRACKET

The switch consists of 2 parts, a stationary element mounted on the motor bracket, and a rotating element mounted on the shaft. The former consists primarily of one stationary and one movable punching, each of which carries 2 heavy copper block contacts insulated from the punching, the contacts on the upper part being short-circuited by a phosphor bronze spring. This part is free to move up and down, thus opening and closing the circuit with the 2 blocks on the stationary part. This movable part is held in either of its extreme positions by means of 2 steel springs near the upper part of the switch, which also give it a certain amount of overtravel so that when it is pushed in one direction through about half of its travel it will jump the remainder of the way.

The operating mechanism for the switch is mounted on the shaft and consists of 3 weights arranged in an approximate ring. These weights run between 2 lips on the sliding part of the switch. When the motor slows down, the springs pull the weights together and they then strike the lower lip, throwing the switch into the closed position. Owing to the overtravel of the switch, the lips move out of contact with the ring in both the open and closed positions so that the only time the rotating part is touching the stationary part is at the moment of transition.

This switch makes a quick, clean break, the contacts are large, permitting rapid radiation of heat, and by thus keeping the contacts cool reduces arcing.

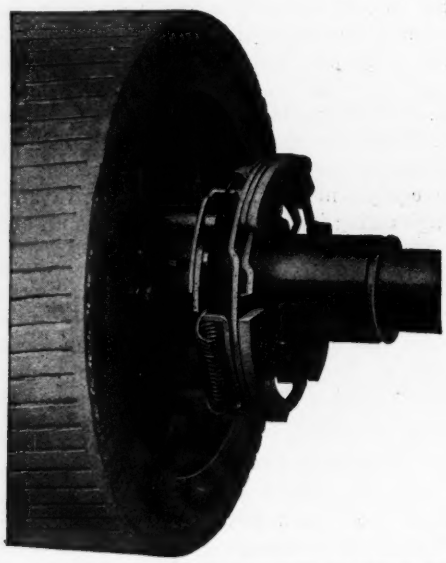


FIG. 2. ROTATING ELEMENT MOUNTED ON ROTOR SHAFT

The mounting of the stationary element is metal, insuring correct alinement and spacing, while the only insulation employed is the bakelite micarta used to separate the contacts from the punchings.

Mechanical Soot Blowers Offered with B. & W. Boilers

SOME years ago, a well known combustion engineer made the statement that mechanical soot blowers would eventually be universally considered absolutely necessary to the proper operation of any high-pressure boiler.

Each year, the necessity of mechanical soot blowers has become more and more apparent. Now the Babcock & Wilcox Co. comes forth with the announcement that it has adopted Diamond Mechanical Soot Blowers, built by the Diamond Power Specialty Co., of Detroit, as standard equipment for all boilers it builds.

The decision was based, as stated by E. H. Wells, president of the Babcock & Wilcox Co., on simple design, good construction, and use of "calorized" metal, to give durability.

This action on the part of the Babcock & Wilcox Co. is strong evidence of the desirability of mechanical soot blowers for the economical and efficient operation of a boiler.

Brady Steam Jet Ash Conveyor

IN the Brady Steam Jet Ash Conveyor, ashes are moved by suction created by the passage of large volumes of air at a high velocity through a pipe line made up of suitable lengths of extremely hard and wear-resisting pipe cast from a specially prepared mixture of iron known as Brady Metal. The air used for this purpose is admitted through the intake end of the conveyor pipe and is set in motion by one or more steam jets placed between ash intakes and points of discharge, the number of jets employed depending upon the capacity and length of conveyor.

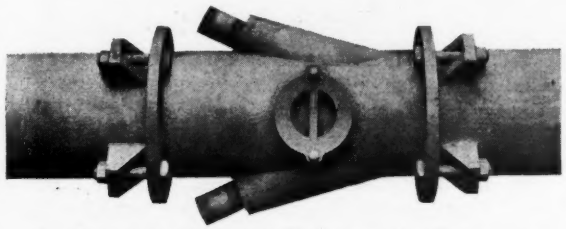


FIG. 1. BRADY STRAIGHT LINE STEAM JET FITTING

The steam jet is obtained by means of divergent or expansion nozzles, generally placed in an elbow provided for the purpose at the top and bottom of a vertical riser, or if there is no riser, at an angle turned either in the same plane with, or at a point where an inclined pipe is projected from the end of a horizontal run of pipe. Where the length of horizontal run exceeds 100 ft., one or more straight line steam jet fittings must be used in addition to those at the elbows. The 2 steam jet nozzles in the straight line fittings are so placed as to cause the steam issuing from them to converge at the axis of the pipe so as not to impinge upon the body of the fittings with consequent cutting action.

Two sizes of conveyors are manufactured, one with pipe 6 in. inside diameter for capacities up to 3 tons per hour, and one with an 8-in. pipe for capacities of from 3 to 8 tons per hour. The pipe used for this purpose is provided with walls 1 in. thick throughout and will convey on an average about 60,000 tons of ashes before replacement is necessary.

The ash intakes are placed in front of ash doors or in ash pits so that the ashes may be raked with a single sweep of the hoe from pit to intake, thus avoiding rehandling. Each intake is provided with a tightly-fitting plug, the lower part of which is concave in outline conforming to inside curvature of pipe to prevent the formation of air pockets.

Baffle boxes placed at discharge ends of conveyors are each provided with a swinging baffle made of Brady Metal over 2 in. thick at the point of maximum impact. It hangs on knife-edge lugs cast on the side of the box and is easily inspected or renewed by raising a hinged cover.

All angle fittings are provided with renewable wearing backs 2 in. thick, made of Brady Metal. These backs are made symmetrical, so that when worn they may be changed end for end and their usefulness doubled. An inspection handhole plate at the side of

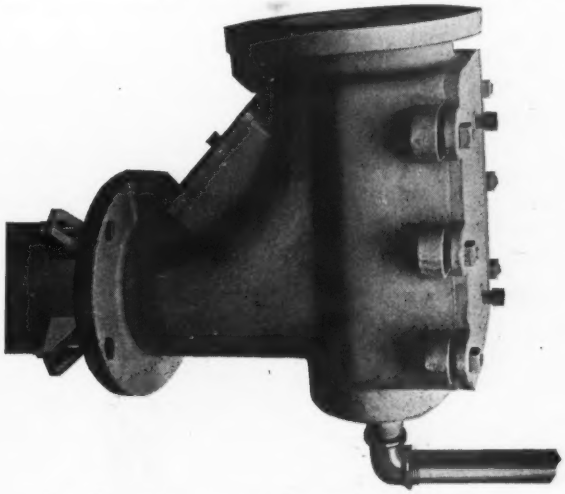


FIG. 2. BRADY STEAM JET ELBOW, ASSEMBLED

elbow permits progress of wear of wearing back being noted from time to time and gives warning when renewal is necessary.

Brady Steam Jet Ash Conveyors are the product of the foundry of The James A. Brady Foundry Co., Chicago.

Henry G. Stott

HENRY GORDON STOTT, whose name has been associated with important improvements in power plant practice for many years, died at his home, New Rochelle, N. Y., after a long illness.

Born in Orkney Islands, Scotland, in 1866, he was educated by his father, Rev. David Stott, and in the elementary schools, and entered Watson Collegiate School at Edinburg. He graduated in 1885 from Glasgow College of Arts and Sciences, and engaged in laying and repairing cables for the Anglo-American Telegraph Co., with the steamer Minia. In this service, he was connected with the duplexing of the longest cable of that type, for the U. S. Cable Co., and also devised many improvements in methods of cable laying and repair.

Mr. Stott entered the power field in 1899 as assistant engineer at the plant of the Brush Electric Engineering Co. at Bournemouth, but in 1890 and '91 went to Madrid, Spain, to assist in construction of a power plant and underground cable system.

Completing that work, he came to this country to install a similar plant for the Buffalo, N. Y., Light & Power Co., and as a consequence of remarkable success in the work became engineer for the company in which position, during the next 10 yr. he did much pioneer work in construction and operation along unusual lines.

Because of the attention which his success attracted, he was asked in 1901 to become superintendent of motive power for the Interborough Rapid Transit Co. of New York City, which was then being organized, and undertook the task of creating the operating organization and completing the 74th St. plant, the substations and transmission system. With the consolidation of the Manhattan and Interborough systems in 1904, Mr. Stott, in a like position, undertook the construction of the 59th St. plant, and has since been in charge of the entire power system of the transportation lines, subway, surface and elevated of New York, which are operated by the Interborough.

In the construction of the New River station of the Buffalo General Electric Co., he acted as consulting engineer, and after considering the use of 1000 lb. pressure, finally decided on 275 lb. with 275 deg. superheat in order to get the temperature desired.

His remarkable work in establishing new precedents is well known. The great 7000-hp. horizontal-vertical compound engines of the 74th St. station were the farthest advance in compact power with reciprocating engines, and the addition of 7500 kw. exhaust steam turbines to these units, giving an increase of 100 per cent in capacity, was a notable achievement. By this combination there was a gain in efficiency over the engines alone of 25 per cent, and over all turbine installations of that time of 13 per cent, with a wide load range of efficient operation.

Later the very large turbine units became available and Mr. Stott was one of the first to adopt them, and was first to utilize the advantages of the cross-compound type of which he had ordered one of 60,000-kw. rating.

In boiler practice he also made great advances, using the double end stoker setting under boilers at the 59th St. plant and thus securing capacities greatly above rating for handling peak loads.

But his activity did not stop in the plant. He was earnest in every effort to advance the standing of the engineering profession, serving as president of the American Institute of Electrical Engineers in 1907-8, vice-president of the American Society of Mechanical Engineers 1912-14, director of the American Society of Civil Engineers in 1911, and when he died was vice-president and trustee of the United Engineering Societies. The work of many important committees was guided and assisted by his thought and clear comprehension of vital facts, and the proceedings of all the societies are richer and more valuable because of his frequent contributions.

Combining unusual executive ability with analytical engineering faculty and large common sense and practical experience, he not only achieved much of great importance himself, but brought out in his associates the wish and the power to do the best work possible.

Early in his residence here he became a citizen of the United States and served 5 yr. as a member of the 74th Regiment, N. G. of New York. He was married in 1894 to Anna Mitchell, of Belfast, Ireland, who, with a son and daughter are left to treasure the memory of a husband and father who was one of the most remarkable engineers of the country, and the valued friend of those who were fortunate enough to know him.

News Notes

HUBER HAND STOKER CO., INC., announces the removal of its main office to Providence, R. I., to which all communications are to be sent. A New York City office will be maintained at 21 Park Row.

H. G. BRINCKERHOFF has recently become identified with The Engineer Company, 17 Battery Place, New York, and is in charge of the company's work in the New England States, being located at 10 High St., Boston, Mass.

E. B. MERRIAM, for several years assistant engineer of the switchboard department of the General Electric Co., has resigned his position to assume much more important duties. He now heads the industrial service department recently organized to supervise education, employment, and provision of opportunities for advancement of employes at the Schenectady plant of the company.

Mr. Merriam brings to his new position a broad and sympathetic understanding of the requirements of the situation. He has been connected with the General Electric Co. for 16 yr., starting as a student in the testing department and later doing service in commercial, manufacturing and engineering development and research work. He is well known among electrical men as a prominent member of the American Institute of Electrical Engineers and particularly for his work in connection with high voltage automatic circuit interrupting apparatus, and has contributed a number of technical papers to A.I.E.E., N.E.L.A., etc., on protective apparatus. He was chairman of the Schenectady section of the Institute in 1913.

U. S. CIVIL SERVICE COMMISSION announces an examination for mechanical draftsman. Vacancies occurring in the Office of the Chief of Ordnance, War Department, Washington, D. C., at entrance salaries ranging from $1000 to $1200 will be filled from this examination. Until further notice applications will be received at any time and the papers will be rated immediately upon their

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly will be sent you for 20

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

PRACTICAL ENGINEER

VIBRATION TROUBLES OF IMPULSE TURBINES

By Eustis H. Thompson

Out-of-Line Vibration

Case 1. Bearings out of line.—Characteristic is good operation at no load; vibration of slow and variable periodicity increasing with load. In excessive cases, some vibration at no load with heating and bad vibration at full load.

Case 2. Bad wheel casing alinement causing internal packing to bind. Characteristic is vibration with temperature effect, pounding noise.

Case 3. Wheel casing alinement causing nozzles to be out of line. Variable vibration at no load only noticeable on bad flexible foundations.

Case 4. Self-alining bearing at fault. Characteristic, bad vibration at intervals, localized to end of turbine.

Bad alinement, due to magnetic elements; governor parts and minor shafts; caused by outside agencies.

Vibration Caused by Unbalance

Case 5. General example of unbalance. Characteristic, even continuous shake at no load, slightly better at full load, same periodicity as speed; excessive cases, lower periodicity and variable, due to bearing action.

PRACTICAL ENGINEER

Vibration Troubles of Impulse Turbines (Cont'd)

Vibration Caused by Packing Trouble

Case 12. Ring too small for shaft. Characteristic, vibration with localized heating.

Case 13. Ring jammed against shaft. Characteristic, vibration with pounding noise.

Metallic packing poorly fit; degree of trouble depends on type of turbine.

Vibration Due to Foundation Troubles

Case 14. Thrown out of line by expansion. Characteristic, out of line shake.

Case 15. Settling of foundation, causing out of line trouble.

Case 16. Sympathetic vibration. Characteristic, induced vibration in foundation, piping, etc. Steel structures; improper grouting.

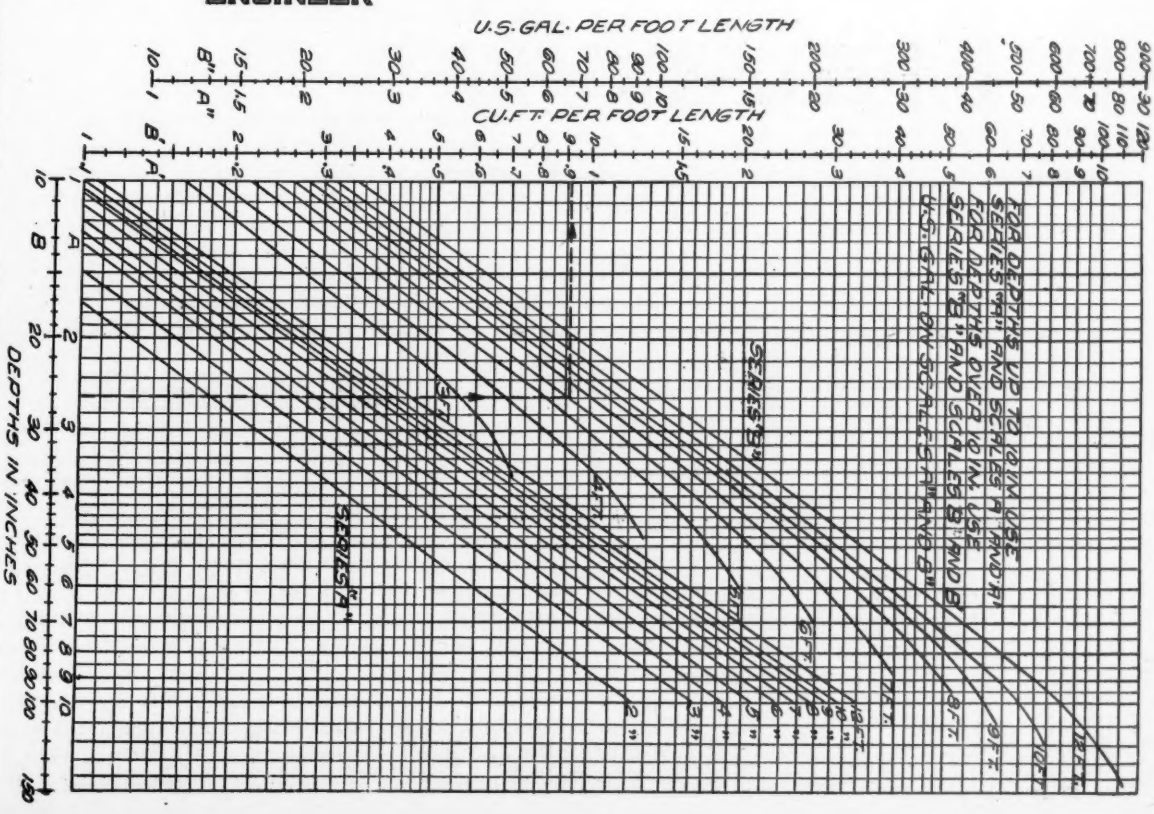
Vibration Due to Water and Steam Troubles

Water does not affect small stout turbines. Causes vibration in larger machines. Characteristic, slows small turbines; like out of line vibrations in medium machines, low periodicity; like unbalanced shake in large machines. Expansion and contraction troubles; impurities in steam.

Case 17. Vibration caused by bad operation of valve gear. Characteristic, variable shakes.

PRACTICAL ENGINEER

CHART FOR FINDING CONTENTS OF CYLINDRICAL TANK WITH HORIZONTAL AXIS


U.S. GAL. PER FOOT LENGTH
CU. FT. PER FOOT LENGTH
DEPTHS IN INCHES
SERIES "A"
SERIES "B"
FOR DEPTHS OVER 70 IN USE SERIES "A" AND SERIES "B" FOR DEPTHS UNDER 70 IN USE SERIES "B" AND "C"

VIBRATION TROUBLES OF IMPULSE TURBINES (Cont'd)
VIBRATION DUE TO MECHANICAL CONSTRUCTION

Such troubles now practically never encountered.

Case 18. Loose wheels. Characteristic, vibration magnified, jingling or pounding noise.

Case 19. Riveted construction loose. Characteristic, bad shake caused by load.

Case 20. Wheels and shaft developed spring when hot. Characteristic, vibration directly influenced by temperature.
Sprung shafts not generally cause of trouble.

Case 21. Loose fit on ball of self-alining bearing. Pounding noise. Tight and loose bearings. Flat spots on shaft. Eccentric coupling.

VIBRATION CAUSED BY ELECTRICAL END

Case 22. Loose joint in armature winding. Characteristic, violent vibration increasing as load; bad commutation; black bars.

Case 23. Loose terminal on revolving field. Characteristic, violent vibration when field current is applied.
Bad alinement of magnetic elements seldom cause of trouble.

VIBRATION TROUBLES OF IMPULSE TURBINES (Cont'd)

Case 6. Unbalance caused by steam containing acid that eroded the balance weights. Effect of dirt.

Case 7. Good balance obtained, but bad operation resulting by combined pull of balance weights against bearing. Characteristic, variable conditions of shake. Remedy to give each rotating part a separate rotating balance.

Case 8. Correcting a bad spring in shaft by arrangement of balance weights.
Couplings and minor parts unbalanced; uneven castings.

VIBRATION CAUSED BY BEARING AND OIL TROUBLES

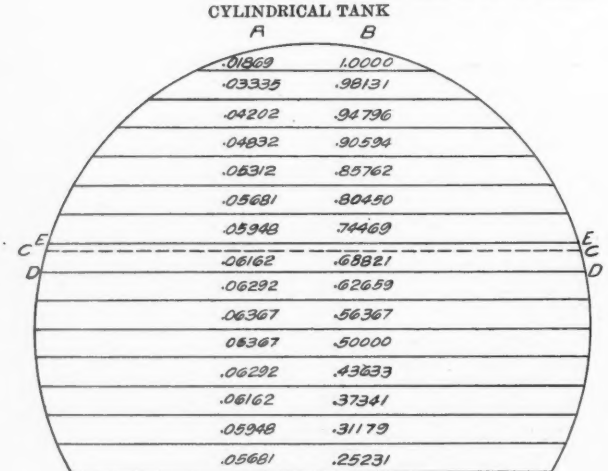
Poor oil; improper care of oil.

Case 9. Oil supply cut off bearing. Characteristic, violent vibration, worse at bearing, with heating. Effect of reducing oil pressure; breaking down of oil film. Shaking with noise and heating.

Case 10. Bearing pinching shaft. Characteristic, violent shake localized somewhat at bearing, with small heating. Machine was kept running a week until repairs could be made. Bearings too loose or too tight.

Case 11. Vibration, due to thrust bearing. Characteristic, localized shake with heating. Step bearings.

QUICK METHOD FOR CALCULATING AREA OF SEGMENT OF A CIRCLE, PARTICULARLY APPLICABLE TO FINDING CONTENTS OF A HORIZONTAL CYLINDRICAL TANK



Figures in column A represent areas of strips 1/20 D in width in circle of unity area. For strips in other circles similarly located, multiply corresponding figures in column A by total area of circle.

Figures in column B represent total areas in segments below chord above figure in circle of unity area. For other circles and similar segments multiply figures by area of circle.

When the level of the liquid is between two chords representing even twentieths, for practical purposes the area in any one strip may be considered as proportional to the height of the strip. For example: If C-C represents the level of the liquid in the tank, we note that it is closely 0.7 the distance from line D to line E. The area of the strip bounded by lines D-D and C-C is 0.7 of 0.06162 or 0.043134 approximately, and the total area of the segment below C-C is 0.62659 plus 0.043134 = 0.669724.

receipt, in order that appointments may be made with the least possible delay. The register of eligibles will be established one month from the date of issue of this announcement, and each month thereafter the names of those passing the examination will be added thereto. As a prerequisite, the applicant must show that he has graduated from a 4 yr. course in engineering from a college of recognized standing or that he is a senior student and expects to graduate within 6 mo. from the date of making oath to his application; or that he has had at least 3 yr. experience as a mechanical draftsman. Applicants must have reached their eighteenth birthday on the date of making oath to the application. Apply for Form 1312.

THE FOLLOWING-NAMED U. S. Civil Service examinations will be held on March 14, 1917: Aid, Coast and Geodetic Survey (men only); Apprentice plate cleaner, transferer, and engraver, Bureau of Engraving and Printing (men only); Assistant, Philippine Service (men only); Assistant examiner, Patent Office; Assistant inspector of boilers, Steamboat-Inspection Service (men only); Assistant inspector of hulls, Steamboat-Inspection Service (men only); Computer, Coast and Geodetic Survey (men only); Draftsman—Copyist, Topographic, Departmental Service; Draftsman—Junior architectural, Supervising Architect's Office; Draftsman—Topographic, Departmental Service; Editorial clerk, Departmental Service; Electrician, Departmental Service (men only); Engineer, second class (or assistant), steam, Departmental Service (men only); Fish culturist, Bureau of Fisheries (men only); Junior chemist, Departmental Service; Junior engineer, civil, Engineer Department at large (men only); Junior engineer (civil) and draftsman, Departmental Service (men only); Junior engineer, mechanical or electrical, Engineer Department at large (men only); Laboratory apprentice, Bureau of Standards (men only); Local inspector of boilers, Steamboat-Inspection Service (men only); Local inspector of hulls, Steamboat-Inspection Service (men only); Physician, all services except Philippine (men only); Teacher, Philippine Service; Telegraph operator, Departmental Service; Telephone operator, Departmental Service; Veterinarian, Bureau of Animal Industry, Philippine Service (men only).

Application forms and full information may be obtained by addressing the U. S. Civil Service Commission, Washington, D. C.

Books and Catalogs

PIPE AND THE PUBLIC WELFARE, by R. C. McWane, 165 pages, 77 illustrations, first edition; New York, 1917. Price, cloth, $1.

Beginning with the crude clay pipe employed in the Babylonian days, 4000 yr. B.C., Chapter I briefly records the development of the various forms of water and gas piping up to the modern types of conduit. This historical description concludes with an outline of the progress made in extending the water and gas service lines of New York City.

Chapter II is devoted to a description, with numerous illustrations, of the materials and methods of making metal pipe. The processes followed in casting, welding or drawing of the different forms of iron and steel pipe are clearly described.

Technical and historical data on metal pipe deterioration is given in Chapter III, and included in the discussion are several papers and reports which cite the non-corroding properties of cast-iron piping. Wood pipe, in various applications, is considered in the concluding chapter.

THE MANUAL FOR ENGINEERS, published by the University of Tennessee, Knoxville, Tenn., is now in its 20th edition, and as all rules and tables contained in it have been carefully revised 20 times, the chances for error have been eliminated. It is a vest pocket size, containing 160 pages of tabular matter most commonly used by the engineer. This includes areas and circumference of circles, powers and roots of numbers, dimensions of square and round iron bars and sheets, trigonometry functions, logarithmic tables, properties of saturated steam, earthwork tables, friction in pipes, strength of materials, wire tables, strength of ropes, interest tables and many others. The book is substantially bound in leather, and can be obtained at 50 cents per copy from the University of Tennessee Press.

BULLETIN NO. 27, of the A. M. Byers Co., of Pittsburgh, Pa., has just come from the press.

The properties that make Byers genuine wrought-iron pipe so desirable when considered in the light of fabricating qualities, resistance to corrosion, ability to withstand severe shocks, vibratory stresses, and other physical strains, do not lend themselves to accurate mathematical expression, but appreciation of the existence of such qualities may be obtained by a study of service records extending over half a century.

To bring out these facts, is quoted the experience of a number of practical men, and at the end of the bulletin is an explanation of the resistance to corrosion, etc., which, aside from being plausible and extensively accepted, also bears out the results obtained in actual service.

The last page takes up the subject of Average Experience versus Exceptional Cases, and shows that it is only by taking the broader view of comparing the accumulated experience of practical men in every walk of life, not only as to the life of pipe, but of sheets, nails, wire, and other iron and steel products, that a sound basis of comparison can be established.

THE S K F BALL Bearing Co. has just issued a new catalog describing and illustrating its various products, also containing articles upon such subjects as Power Saving, The Use of Small Motors, The Saving in Lubrication and Inspection, Reduced Fire Hazards, etc. The book also contains valuable tables and curves, and engineering data upon mounting, lubrication, testing lubricants, felt seals, etc. Copies may be had by addressing the S K F Ball Bearing Co., Hartford, Conn.

THE THIRD annual edition of Sweet's Engineering Catalog has been received, and contains a large, well arranged list of firms manufacturing material for engineers and contractors. It is carefully arranged, well indexed, and presents a good typographical appearance. The annual revision insures correctness of addresses, and the classified arrangement gives convenience in referring

to various lines of industry. Catalog is issued by Sweet's Catalog Service, Inc., 115 West 40th St., New York City.

GRINNELL AUTOMATIC SPRINKLER Bulletin No. 87, from General Fire Extinguisher Co., Providence, R. I., discusses fire protection particularly in relation to ships, hotels, country houses, exposure fires, interruption loss and labor loss.

WORTHINGTON Pump and Machinery Corporation, 115 Broadway, New York, is sending out its new calendar illustrated with views of plants equipped with the company's machinery.

Trade Notes

WARREN WEBSTER & CO., Camden, N. J., announces the appointment of Eugene P. Bradley and Thomas J. Hester as St. Louis district managers. A branch office will be maintained in the name of Warren Webster & Co., at 1212 Chemical Bldg.

PLANS HAVE BEEN FILED for A. Allan & Son's new 50 by 100-ft. foundry to be erected at South Fifth and Bergen Sts., Harrison, N. J., at a cost of $15,300.

Frederick A. Phelps, M. E. and architect, Newark, N. J.; Frederick K. Kilgus, Inc., Newark, N. J., contractor. This is the first of 3 buildings which the company contemplates erecting on this site.

THE SCHAEFFER & BUDENBERG MFG. CO., of Brooklyn, N. Y., announces the establishment of a selling office in St. Louis, Mo., under the direction of A. H. Reuter, who was formerly connected with the Chicago office.

The principal selling offices of this company are now Brooklyn, N. Y.; Philadelphia, Pa.; Pittsburgh, Pa.; Chicago, Ill.; St. Louis, Mo.; Los Angeles, Cal.

ANNOUNCEMENT has just been made by the Westinghouse Electric & Mfg. Co. that the plot of ground recently purchased at Essington, near Philadelphia, will form a new industrial center for the Westinghouse electric interests. The site embraces about 500 acres, with a frontage of approximately one mile on the Delaware River. Additional transportation facilities will be afforded by tracks from the Pennsylvania and Philadelphia and Reading railroads.

This new center will be devoted to the production of large apparatus, the first group of buildings being for power machinery, principally steam turbines, condensers, and reduction gears. The initial development will cost in the neighborhood of $5,000,000 or $6,000,000, occupying about 1/5 of the area of the entire plot. The group will consist of the following buildings: Two large machine shops, an erecting shop for heavy machinery, forge shop, pattern and pattern-storage shop, and power house. Work will begin on these as soon as satisfactory building contracts can be let.

The number of employes to be engaged at the new plant has not as yet been definitely determined, but will number several thousand people, and undoubtedly will in the future equal the number employed at East Pittsburgh, representing over 20,000 people.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

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Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,000.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—I am a thoroughly competent power plant engineer, accustomed to handling on high efficiency basis all types of steam engines and turbines, a.c. and d.c. machines, strictly sober. 34 years old, married. Want charge of good plant in Chicago that will pay at least $25.00 per week. Address Bor 455, Practical Engineer, 537 S. Dearborn St., Chicago. 1-15-2

POSITION WANTED—By engineer 30 years old, married; 7 years' experience with Corliss and high speed engines, refrigeration and d.c. generators. Address Lee McCallum, 512 N. Park, Cadillac, Mich. 1-15-2

POSITION WANTED—I am a thoroughly competent power plant engineer, accustomed to handling on high efficiency basis all types of steam engines and turbines, A.C. and D.C. machines; strictly sober; 34 years old, married. Want charge of good plant in Chicago that will pay at least $25.00 per week. Address Box 455, Practical Engineer, 537 S. Dearborn St., Chicago. 2-1-1

POSITION WANTED—As chief engineer in industrial plant, Missouri, Arkansas, Kansas, Iowa or Nebraska, or as Superintendent of light and water plant in city of 2500 to 8000. Ten years' practical experience with steam, electrical and water systems. Technical training. Now employed by U. S. Government as engineer and instructor. Executive ability. Can report on 15 to 30 days' notice. Married. Age 30. Address Practical Engineer, Box 466, 537 S. Dearborn St., Chicago, Ill. 2-1-1

POSITION WANTED—As engineer in small plant or assistant in large power plant. Have had 5 years' experience as engineer in grain elevator. Am good mechanic, sober and steady habits; 28 years old. Central States preferred. Fair salary to start. Address Box 115, Walcott, Ia. 2-15-2

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco Cal.; Washington, D. C. This is an excellent chance for a hustler who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

SALES OPPORTUNITY—Reputable well advertised grate company wishes to co-operate on sales with concern selling product to power plants using grates. Any suggestion considered. Address Practical Engineer, Box 468, 537 S. Dearborn St., Chicago, Ill. 2-15-1

WANTED—A first class fireman to look after twelve 150-hp. tubular boilers; one who is well up in economy in coal and understands thoroughly the care of boilers; must be sober, industrious and steady. A good position for the right man. Address Practical Engineer, Box 469, 537 S. Dearborn St., Chicago, Ill. 2-15-3

Wanted

WANTED—Agents handling engine and boiler room specialties in every section fo side line paying large commissions. Give experience, line carried and territory covered. Boy 381, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

FOUR COPIES of Practical Engineer for February, 1910, in good condition; we will extend your subscription for three months. Circulation Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill.

WANTED—A full set of International Correspondence School volumes on Steam and Mechanical Engineering and on Electrical Engineering. Must be in good condition. State price in first letter. Address Practical Engineer, Box 467, 537 S. Dearborn St., Chicago, Ill. tf.

MARINE BOILERS WANTED—From 50 to 250 horsepower. We will pay cash awards for information that leads to a purchase. The Fittsburgh Boiler & Machine Co., Pittsburgh, Kans. 1-1-6

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it on test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

For Sale

FOR SALE—Two model stokers in splendid condition, only two years in use; 8 ft. furnace, suitable for 300 to 400-hp. boilers. Address Practical Engineer, Box 470, 537 S. Dearborn St., Chicago, Ill. 2-15-1

FOR SALE—250-125 volt, 3 wire direct connected units, 100-kw. Westinghouse with Erie engine, $1675. 75-kw. General Electric with Buckeye engine, $1250. Power Machinery Exchange, Jersey City. 2-15-1

Patent and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf.

VALUABLE PATENTS—Honest advice. Personal service. Write for "The Truth About Patents." J. R. KELLY, 740R Woodward Bldg., Washington, D. C. 2-15-1

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C.

PATENTS—Send sketch for free search and reports. Books and patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time, to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

Advertising Helps to Keep Prices Down

Two prominent business men were talking things over not long ago. One of them asked the other, "What is the most common delusion in the business world today?" Instantly came the reply, "The idea that advertising adds to the price of goods."

Every now and then some manufacturer has the hardihood to say that he can sell his goods cheaper because he doesn't advertise. Every one who knows the A B C of business knows that this claim is impossible on its face. Yet it sounds plausible and such talk deceives millions of people.

Forget all these sophistries and listen now to the plain common sense of the matter.

In the production and marketing of goods there are two inevitable costs. One is the manufacturing cost; the other is the selling cost. And no way has ever yet been found by which either of these costs can be eliminated. Mark that.

Whether you buy farm products at a grocery store, or mill products at a dry goods store, or laboratory products at a drug store—whatever you buy at any store, be sure of one thing: The price includes the selling cost. It must, else the manufacturer, the wholesaler, the retailer and the salesman could not live.

And just as surely as there are always two items of cost, the manufacturing and the selling, just so surely are there only two ways in which the price of goods can ever be reduced.

One is by economies in manufacturing cost. The other is by economies in selling cost.

Of course, it isn't easy to cut manufacturing cost without cutting the quality.

But in modern times a way has been found to cut selling cost—and its name is Advertising.

Advertising is like a straight line: the shortest distance between two points—the producer and the consumer. It cuts out the grades, curves and the angles. It makes a drop of ink do the work of a salesman. Bear in mind that goods can never be sold unless there is a demand and advertising creates this demand in the simplest, most direct and least expensive way. No other sales method can equal it in magnitude of return for a minimum of cost.

And the big returns from advertising also cut down the manufacturing cost—that's another saving. Increased volume of production always means a decrease in the unit cost of production through better and more efficient manufacturing methods.

The Association of National Advertisers has recently been gathering some remarkable facts and figures on this subject. They show how one after another of the big advertisers of the country have been able to reduce the price of their product or else to improve the quality at no increase in price. It is a significant fact that nationally advertised goods are the only product which, as a class, have not tended to rise in price during the past few years.

Countless causes are working today to force prices up. We all know this by sad experience. Against all these forces one force only is working to keep prices down—and its name is Advertising.